AQUATIC SURVEY OF SELECTED STREAMS WITH CRITICAL HABITATS ON NATIONAL RESOURCE LANDS AFFECTED BY LIVESTOCK AND RECREATION

CENTER FOR HEALTH

AND ENVIRONMENTAL STUDIES

Brigham Young University

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PURPOSE OF STUDY

The purposes of these surveys are to provide aquatic habitat and water quality baseline data to the U. S. Bureau of Land Management (BLM) to be used in the evaluation of: (1) livestock grazing impacts on the flora and fauna of Big Creek, Birch Creek, Thoms Creek, and Trout Creek; and (2) impacts from increased recreational use on the potable water supply and aquatic ecosystem of Rock Creek within Desolation Canyon. These baseline data are to be used in management decision formulation by the BLM for the management of land/water resources on national resource lands (NRL) in Utah.

To be included in the analysis of data from these surveys are: a review of existing surface water records, flows and quality; descriptions of existing aquatic habitats; characterizations of macroinvertebrate communities; and water quality summary for each stream. These data will provide the baseline inventory relating to the specified streams within the Salt Lake, Cedar City, and Moab Districts of the Bureau of Land Management. The assemblage, analysis, and recommendations presented as a result of this study will form the basis for land management decisions and future studies involving aquatic habitats and related fauna in these streams, especially in areas of recreational and livestock grazing impacts.

METHODS AND MATERIALS

Aquatic Habitat

The methods used for aquatic habitat surveys were those described in the preliminary draft BLM manual supplement, Utah State Office 6671--Aquatic Studies (1974) by Don Duff, Fisheries Biologist, Utah State Office, Bureau of Land Management, Salt Lake City, Utah.

Water Quality

Specific conductance and water temperature were measured in the field using a YSI meter. Air temperature was measured with a mercury thermometer. Dissolved oxygen was determined by a modified Winkler Method. Narrow range indicators and a Sargent pH meter were used for pH determinations. Other water chemistry measurements were all completed by one of two Utah Division of Health certified water quality labs: BYU Environmental Analysis Laboratories and U.S. Geological Survey laboratory.

Bacteria samples were analyzed by either Bionics (a certified laboratory in Provo), BYU Environmental Analysis Laboratory, or the Utah State Division of Health Laboratory in Salt Lake City.

Macroinvertebrates

A stratified random method was used in sampling benthic macroinvertebrates. Three or four quantitative samples were "randomly" taken from preselected habitat zones for each area being sampled. Preferred habitat was gravel-rubble riffles when available. The gravel-rubble was sought out because aquatic invertebrates are found in higher diversity in these substrates than in most other bottom types. The sampler used was a modified Surber designed to prevent loss of organisms due to backwash out of the net. Invertebrates were separated, identified, and counted. A list of taxa, numbers per meter square, and two dominance diversity index values for each site for each date were calculated. At one site per stream, a step analysis was completed, including mean number per sample, standard diversity of the means, 80 percent confidence limits, the percent standard error of the mean, the coefficient of variance, $\bar{d}$ and H diversity indices, and the number of taxa. Standard errors should be 20 percent or less of the mean and the coefficient should be less than 50 percent. Step one is based upon only one sample; Step 2 is based upon two pooled samples; Step 3 is based upon three pooled samples; and so forth.

An often used measure of the well being of aquatic communities is the diversity index. The diversity indices are highest (most desirable) when the number of species is high and the number of individuals is evenly distributed over several species. With fewer species or when one or two species account for most of the total number, the diversity indices are low (undesirable). For example, when a stream receives a heavy load of sewage effluent, most mayflies, stoneflies, and caddisflies are eliminated; but the number of midge larvae and sewage worms become extremely high. In such a condition, the diversity index would be low. In clean, cold mountain streams there are usually numerous species of aquatic insects with moderate numbers of individuals for several species, resulting in high diversity indices. Dominance diversity values in this report were computed using the formulas:

$$\bar{d} = -\sum_{i}^{s}(N_i/N)\log_2(N_i/N) \quad \text{(Shannon and Weaver, 1963)}$$

$$H = (i/N)(\log N! - \sum_{i}^{s}\log N_i!) \quad \text{(Brillouin, 1960)}$$

Where: $\bar{d}$ and H are dominance diversity indices
N_i = number of the i'th species
N = total number of all species

Both indices are very similar and are both based upon the information theory. In summary, when several specimens of a sample are examined, more information is gained when the next specimen examined is different from the preceding one than if they were all the same. Thus, these formulas were selected because they are based upon diversity dominance and express the relative importance of each species collected, not merely the relationship between total numbers of species and of individuals. These indices are also independent of sample size.

STUDY AREAS

Streams Under Grazing Impact Analysis

Big Creek

Salt Lake District, Rich County, near Randolph, Utah (Figure 1). This study reach occupies that stream area immediately above, within, and below an existing Bureau stream improvement demonstration area exclosure in T 10N, R 6E, Section 19 (Figure 2). This stream improvement demonstration area is inhabited by cutthroat-rainbow hybrid species. The improvement structures and exclosure were installed in 1970 to show recovery over time of the riparian aquatic ecosystem from the impacts of livestock grazing uses and to evaluate the effectiveness of artificial structures in improving fisheries habitat. The improvement site is still subject to periodic sedimentation from unstable upstream reaches originating on private and NRL. The Cache National Forest boundary is approximately 4 miles above the study site and contains the headwaters of Big Creek. Comparisons of aquatic conditions in the exclosed area to those found above and below the exclosure in continued grazing use areas, will help define future management alternatives for the area.

The watershed consists mainly of a west to east slope of Tertiary Wasatch (Knight) sedimentary formation with some limited exposures of Twin Creek limestone in the headwaters and alluvium and Lake Bonneville deposits in the valley around Randolph, Utah.

In the study area the dominant vegetative community is sagebrush-grass with a few small patches of willows next to the stream. There are a few scattered junipers on the gradual sloping hillsides and some clones of quaken aspen farther up near the hill crests.

The area appears to have been subjected to heavy grazing pressures, especially along the streambanks. Most of the willows are cropped off to bare stems and extended shoreline reaches are barren of any shrubs or tall grasses or weeds.

Big Creek is a major source of irrigation water and also drinking water for livestock and wildlife. The stream in the study area provides angling opportunities for sportsmen from a catchable rainbow trout fisheries managed by the Utah Division of Wildlife Resources, but production of the natural in-stream propagated cutthroat trout is limited.

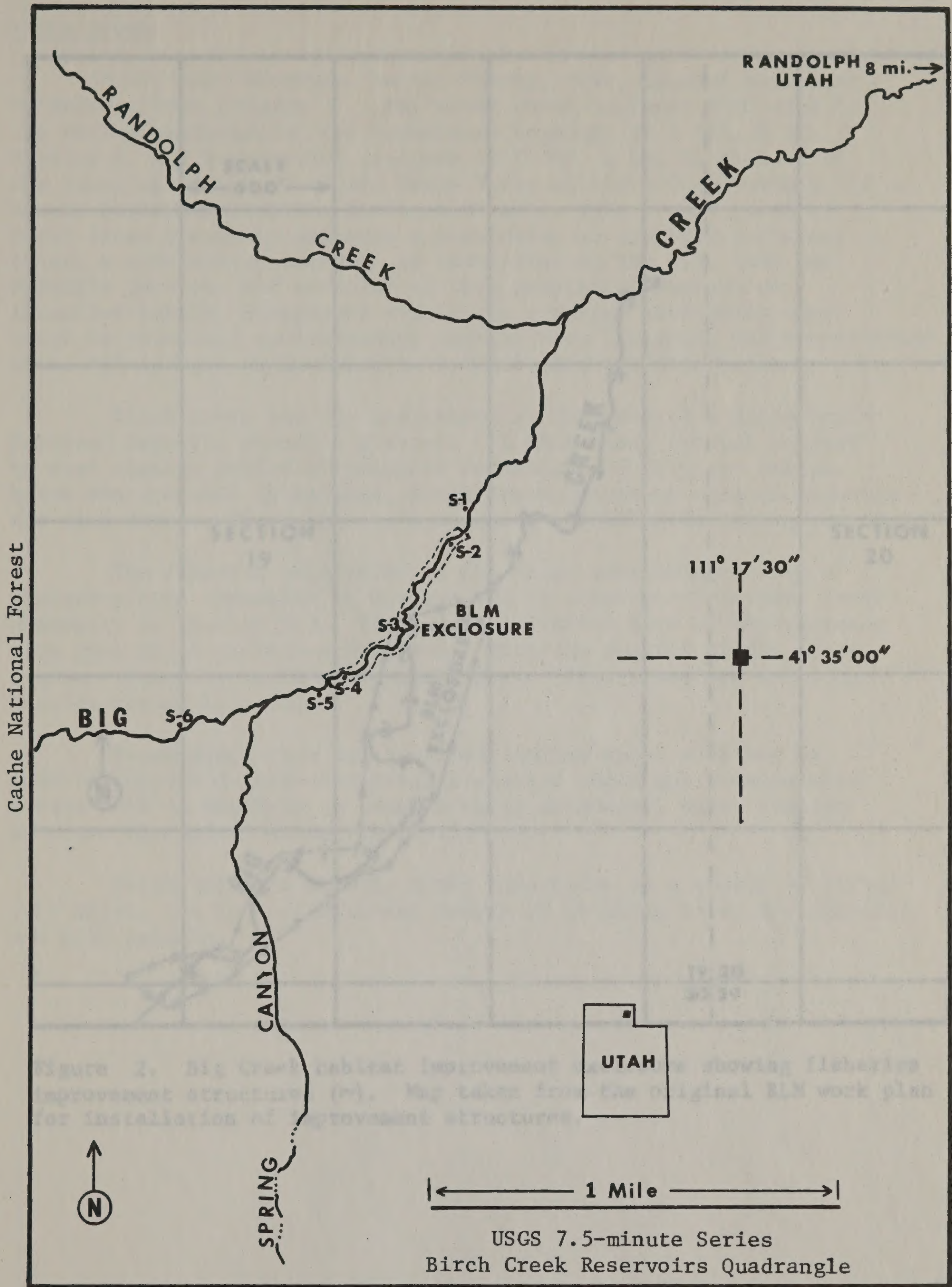

Figure 1. Big Creek study area.

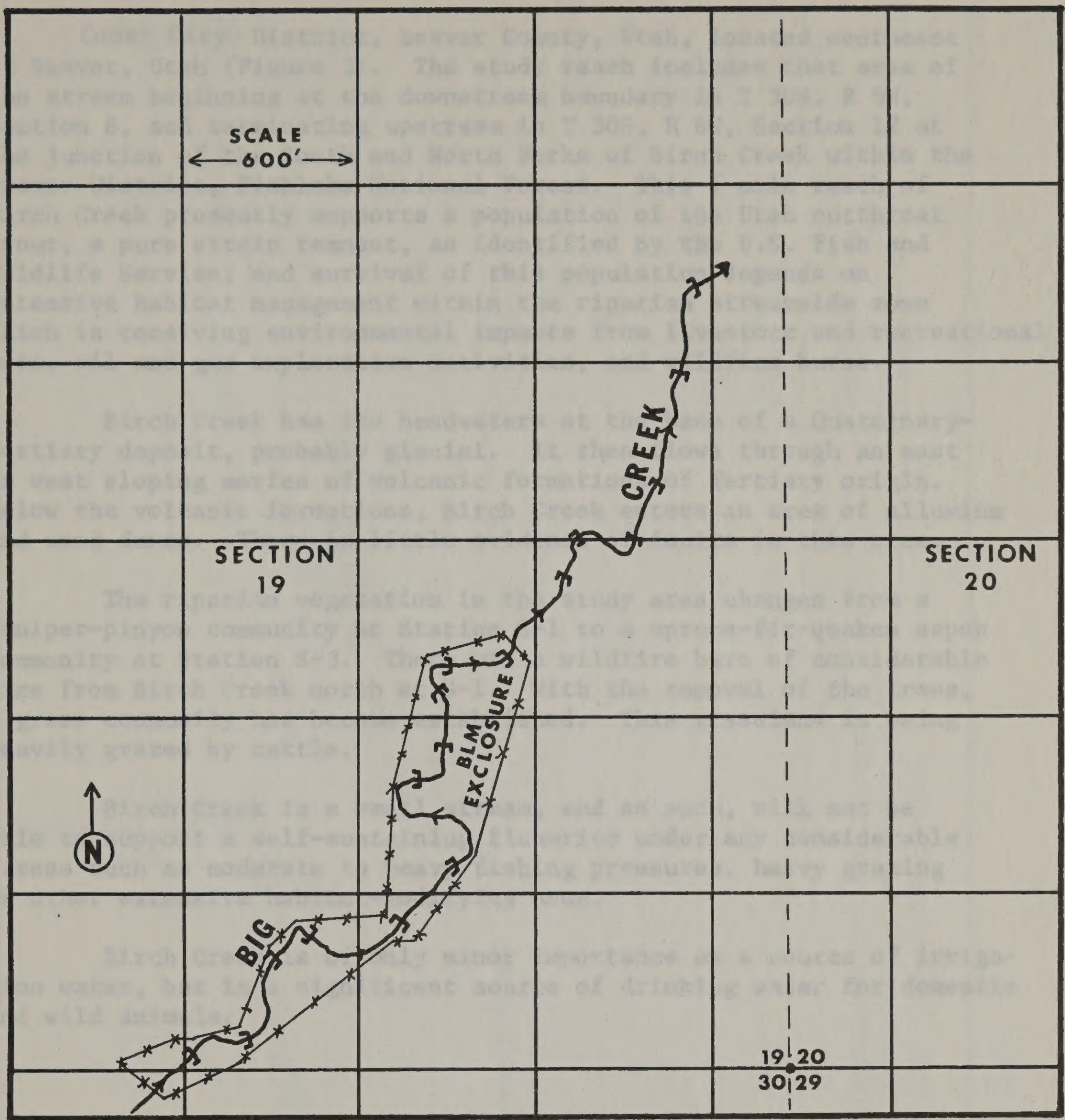

Figure 2. Big Creek habitat improvement exclosure showing fisheries improvement structures (⌐). Map taken from the original BLM work plan for installation of improvement structures.

Birch Creek

Cedar City District, Beaver County, Utah, located southeast of Beaver, Utah (Figure 3). The study reach includes that area of the stream beginning at the downstream boundary in T 30S, R 6W, Section 6, and terminating upstream in T 30S, R 6W, Section 12 at the junction of the South and North Forks of Birch Creek within the Beaver District, Fishlake National Forest. This 6-mile reach of Birch Creek presently supports a population of the Utah cutthroat trout, a pure strain remnant, as identified by the U.S. Fish and Wildlife Service; and survival of this population depends on intensive habitat management within the riparian streamside zone which is receiving environmental impacts from livestock and recreational uses, oil and gas exploration activities, and wildfire burns.

Birch Creek has its headwaters at the base of a Quaternary-Tertiary deposit, probably glacial. It then flows through an east to west sloping series of volcanic formations of Tertiary origin. Below the volcanic formations, Birch Creek enters an area of alluvium and sand dunes. There is little evidence of faults in this area.

The riparian vegetation in the study area changes from a juniper-pinyon community at Station S-1 to a spruce-fir-quaken aspen community at Station S-3. There was a wildfire burn of considerable size from Birch Creek north at S-1. With the removal of the trees, a grass community has become established. This grassland is being heavily grazed by cattle.

Birch Creek is a small stream, and as such, will not be able to support a self-sustaining fisheries under any considerable stress such as moderate to heavy fishing pressures, heavy grazing or other extensive habitat-modifying uses.

Birch Creek is of only minor importance as a source of irrigation water, but is a significant source of drinking water for domestic and wild animals.

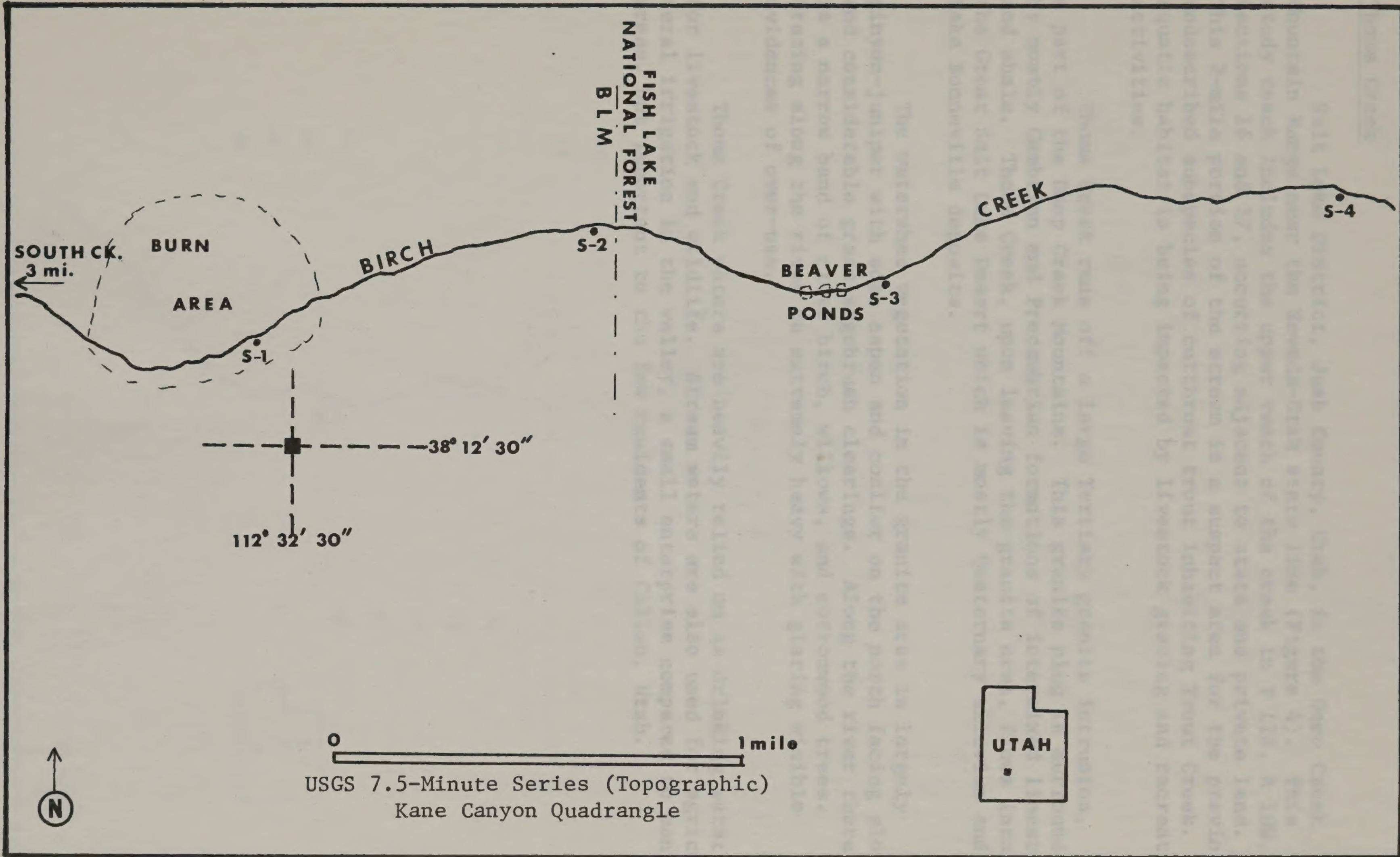

Figure 3. Birch Creek study area.

Thoms Creek

Salt Lake District, Juab County, Utah, in the Deep Creek Mountain Range near the Nevada-Utah state line (Figure 4). This study reach includes the upper reach of the creek in T 11S, R 18W, Sections 16 and 17, occurring adjacent to state and private land. This 2-mile portion of the stream is a suspect area for the previously undescribed subspecies of cutthroat trout inhabiting Trout Creek. Aquatic habitat is being impacted by livestock grazing and recreational activities.

Thoms Creek runs off a large Tertiary granite intrusion, a part of the Deep Creek Mountains. This granite plug is surrounded by mostly Cambrian and Precambrian formations of intermixed limestone and shale. Thoms Creek, upon leaving the granite area, flows into the Great Salt Lake Desert which is mostly Quaternary alluvium and Lake Bonneville deposits.

The watershed vegetation in the granite area is largely pinyon-juniper with some aspen and conifer on the north facing slopes and considerable grass-sagebrush clearings. Along the river there is a narrow band of river birch, willows, and cottonwood trees. Grazing along the river is extremely heavy with glaring visible evidences of over-use.

Thoms Creek waters are heavily relied on as drinking water for livestock and wildlife. Stream waters are also used for agricultural irrigation in the valley, a small enterprise compared to many areas, but important to the few residents of Callao, Utah.

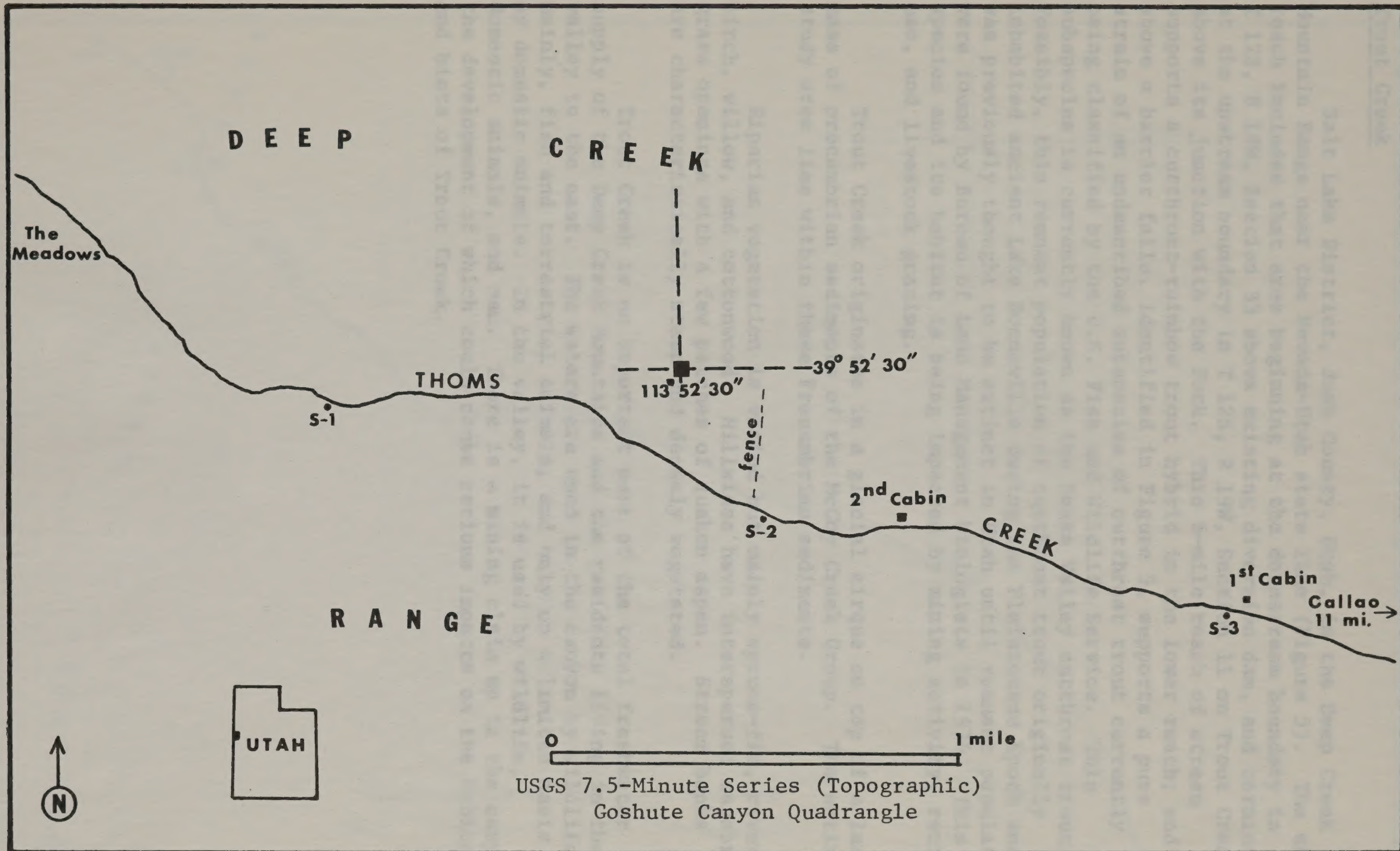

Figure 4. Thoms Creek study area.

Trout Creek

Salt Lake District, Juab County, Utah, in the Deep Creek Mountain Range near the Nevada-Utah state line (Figure 5). The study reach includes that area beginning at the downstream boundary in T 12S, R 18W, Section 33 above existing diversion dam, and terminating at the upstream boundary in T 12S, R 19W, Section 11 on Trout Creek above its junction with the Fork. This 6-mile reach of stream supports a cutthroat-rainbow trout hybrid in the lower reach; and above a barrier falls, identified in Figure 5, supports a pure strain of an undescribed subspecies of cutthroat trout currently being classified by the U.S. Fish and Wildlife Service. This subspecies is currently known as the Snake Valley cutthroat trout. Possibly, this remnant population of cutthroat trout originally inhabited ancient Lake Bonneville during the Pleistocene Epoch and was previously thought to be extinct in Utah until remnant populations were found by Bureau of Land Management biologists in 1974. This species and its habitat is being impacted by mining activity, recreational use, and livestock grazing.

Trout Creek originates in a glacial cirque on top of a large mass of precambrian sediments of the McCoy Creek Group. The entire study area lies within these Precambrian sediments.

Riparian vegetation is varied but mainly spruce-fir, river birch, willow, and cottonwood. Hillsides have interspersed sagebrush-grass openings with a few patches of quaken aspen. Stream banks are characteristically steep and densely vegetated.

Trout Creek is an important part of the total freshwater supply of the Deep Creek Mountains and the residents living in the valley to the east. The waters are used in the canyon by wildlife mainly, fish and terrestrial animals, and only on a limited basis by domestic animals. In the valley, it is used by wildlife, domestic animals, and man. There is a mining claim up in the canyon, the development of which could cause serious impacts on the habitat and biota of Trout Creek.

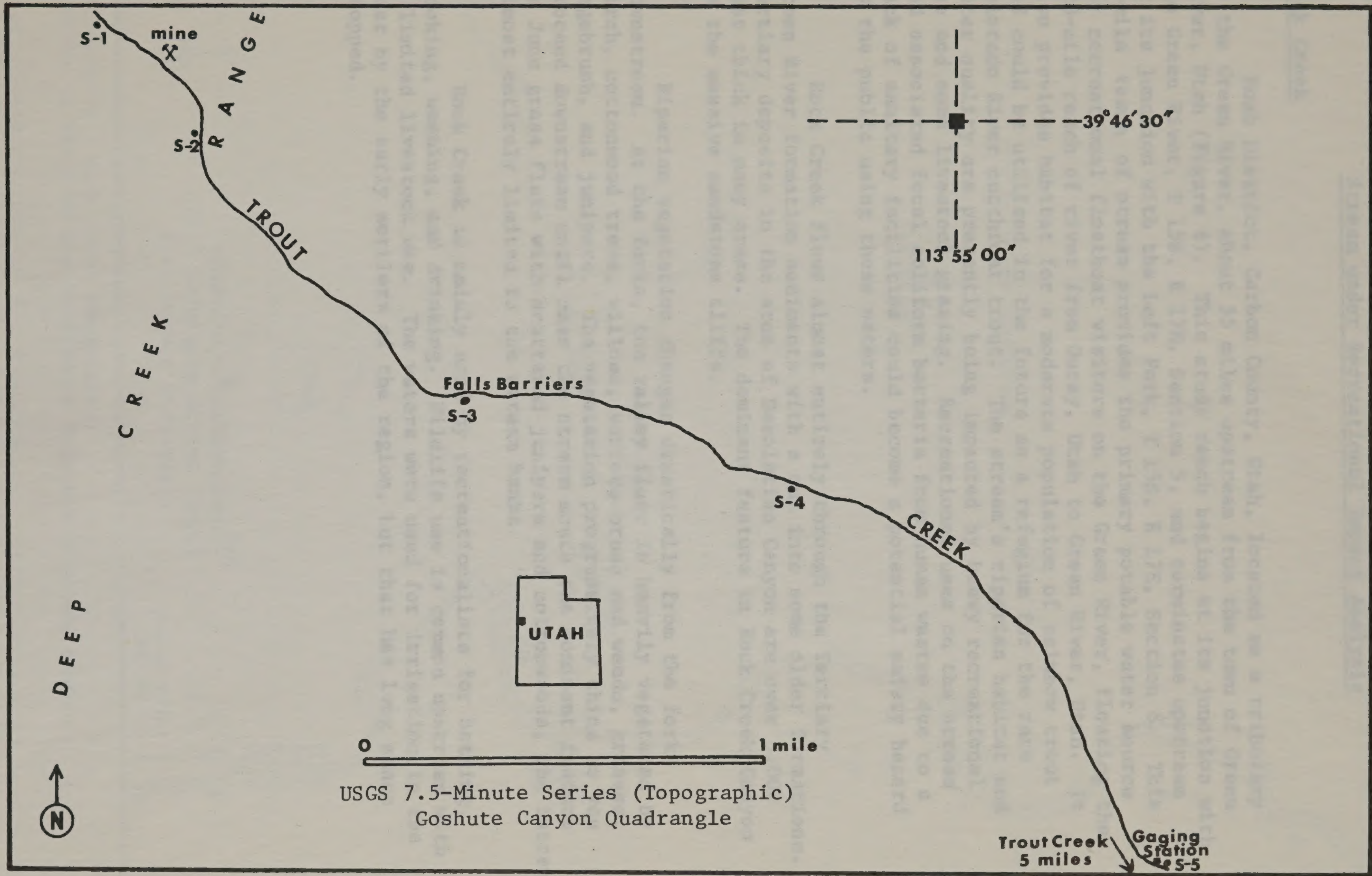

Figure 5. Trout Creek study area.

Stream under Recreational Impact Analysis

Rock Creek

Moab District, Carbon County, Utah, located as a tributary to the Green River, about 55 miles upstream from the town of Green River, Utah (Figure 6). This study reach begins at its junction with the Green River, T 15S, R 17E, Section 5, and terminates upstream at its junction with the Left Fork, T 15S, R 17E, Section 6. This 2-mile reach of stream provides the primary potable water source for recreational floatboat visitors on the Green River, floating the 128-mile reach of river from Ouray, Utah to Green River, Utah. It also provides habitat for a moderate population of rainbow trout and could be utilized in the future as a refugium for the rare Colorado River cutthroat trout. The stream's riparian habitat and water quality are presently being impacted by heavy recreational use and some livestock grazing. Recreational uses on the stream and associated fecal coliform bacteria from human wastes due to a lack of sanitary facilities could become a potential safety hazard to the public using these waters.

Rock Creek flows almost entirely through the Tertiary Green River formation sediments with a cut into some older formations. Tertiary deposits in the area of Desolation Canyon are over 5,000 feet thick in many areas. The dominant feature in Rock Creek Canyon is the massive sandstone cliffs.

Riparian vegetation changes drastically from the forks downstream. At the forks, the valley floor is heavily vegetated by birch, cottonwood trees, willows, various brush and weeds, grasses, sagebrush, and junipers. The vegetation progressively thins as you proceed downstream until near the stream mouth the dominant feature is June grass flats with scattered junipers and cottonwoods, the latter almost entirely limited to the stream banks.

Rock Creek is mainly used by recreationalists for bathing, cooking, washing, and drinking. Wildlife use is common upstream with a limited livestock use. The waters were used for irrigation in the past by the early settlers of the region, but that has long since stopped.

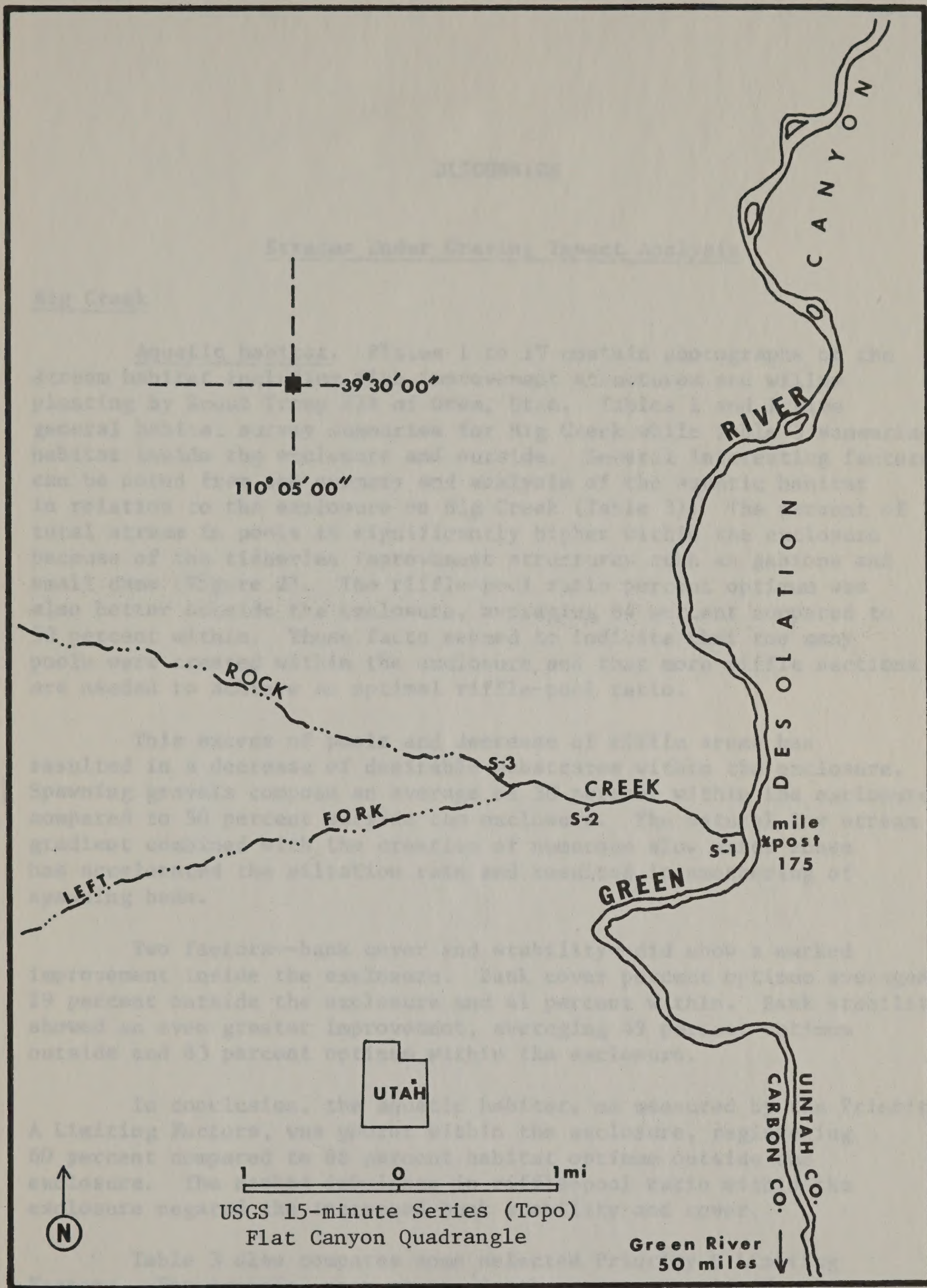

Figure 6. Rock Creek study area.
*River miles from the confluence with the Colorado River.

DISCUSSION

Streams Under Grazing Impact Analysis

Big Creek

Aquatic habitat. Plates I to IV contain photographs of the stream habitat including fish improvement structures and willow planting by Scout Troop 171 of Orem, Utah. Tables 1 and 2 give general habitat survey summaries for Big Creek while Table 3 summarizes habitat inside the exclosure and outside. Several interesting factors can be noted from the summary and analysis of the aquatic habitat in relation to the exclosure on Big Creek (Table 3). The percent of total stream in pools is significantly higher within the exclosure because of the fisheries improvement structures such as gabions and small dams (Figure 2). The riffle-pool ratio percent optimum was also better outside the exclosure, averaging 84 percent compared to 50 percent within. These facts seemed to indicate that too many pools were created within the exclosure and that more riffle sections are needed to achieve an optimal riffle-pool ratio.

This excess of pools and decrease of riffle areas has resulted in a decrease of desirable substrates within the exclosure. Spawning gravels compose an average of 30 percent within the exclosure compared to 50 percent outside the exclosure. The natural low stream gradient combined with the creation of numerous slow water zones has accelerated the siltation rate and resulted in smothering of spawning beds.

Two factors--bank cover and stability--did show a marked improvement inside the exclosure. Bank cover percent optimum averaged 29 percent outside the exclosure and 41 percent within. Bank stability showed an even greater improvement, averaging 49 percent optimum outside and 83 percent optimum within the exclosure.

In conclusion, the aquatic habitat, as measured by the Priority A Limiting Factors, was poorer within the exclosure, registering 60 percent compared to 66 percent habitat optimum outside the exclosure. The marked imbalance in riffle-pool ratio within the exclosure negated the increased bank stability and cover.

Table 3 also compares some selected Priority B Limiting Factors. For example, mean stream depth was greater inside the exclosure. This was probably due to the more numerous pools. Mean channel width was less inside the exclosure which perhaps indicates increased bank stability. Most other factors compared about the same except for an increase in stream shade within the exclosure.

PLATE I

PICTURE 1. BLM STREAM IMPROVEMENT EXCLOSURE ON BIG CREEK, BYU STREAM SURVEY TEAM, JUNE 17, 1975.

PICTURE 2. EXCLOSURE FENCE: RIGHT SIDE IS OUTSIDE AND LEFT SIDE IS WITHIN THE EXCLOSURE, JUNE 17, 1975.

PICTURE 3. RAINBOW AND CUTTHROAT TROUT CAUGHT ABOVE THE EXCLOSURE ON BIG CREEK BY GARY GUMMOW, A BOY SCOUT IN TROOP 171, OREM, UTAH ON JUNE 18, 1975.

PICTURE 4. PLANTING OF WILLOW SHOOTS BY BOY SCOUT TROOP 171 WITHIN THE EXCLOSURE ON JUNE 17, 1975 TO STABILIZE BANK AND PROVIDE COVER FOR FISH.


BIG CREEK
STREAM IMPROVEMENT
THIS AREA TREATED TO IMPROVE STREAM FISHERIES HABITAT.
INCREASED VEGETATION WILL PROVIDE STREAM BANK PROTECTION, INCREASED INSECT LIFE AND STREAM COVER.
THE GABIONS (SMALL DAMS) CREATE POOLS AND GRAVEL BARS VALUABLE TO FISH FOR RESTING, FEEDING AND SPAWNING AREAS.

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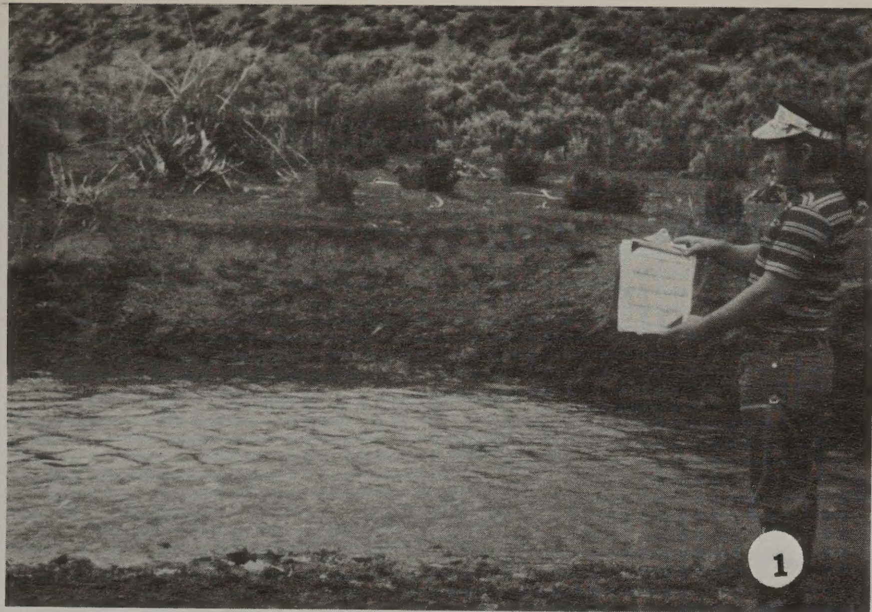
PLATE II

PICTURE 1. BIG CREEK AT SITE S-5, TRANSECT 3 ABOVE THE EXCLOSURE. CATTLE TRAIL SHOWING LACK OF RIPARIAN VEGETATION AND BANK INSTABILITY, JUNE 17, 1975.

PICTURE 2. BIG CREEK SITE S-5 ABOVE EXCLOSURE SHOWING LACK OF STREAMSIDE VEGETATION, AUGUST 21, 1975.

PICTURE 3. BIG CREEK AT SITE S-6 ABOVE EXCLOSURE SHOWING EXCELLENT RIFFLE AREA AND BANK EROSION, AUGUST 21, 1975.

PICTURE 4. BIG CREEK AT SITE S-5 ABOVE EXCLOSURE SHOWING BANK INSTABILITY, JUNE 17, 1975.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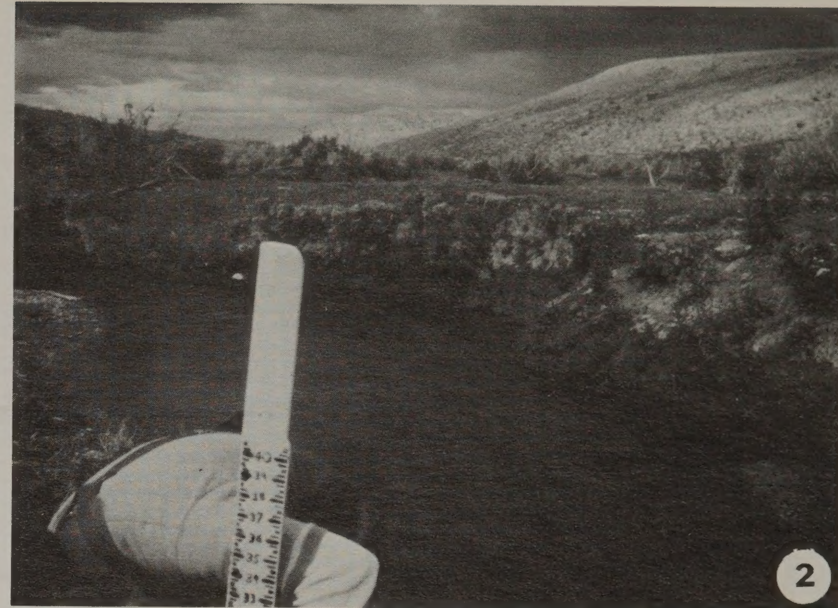
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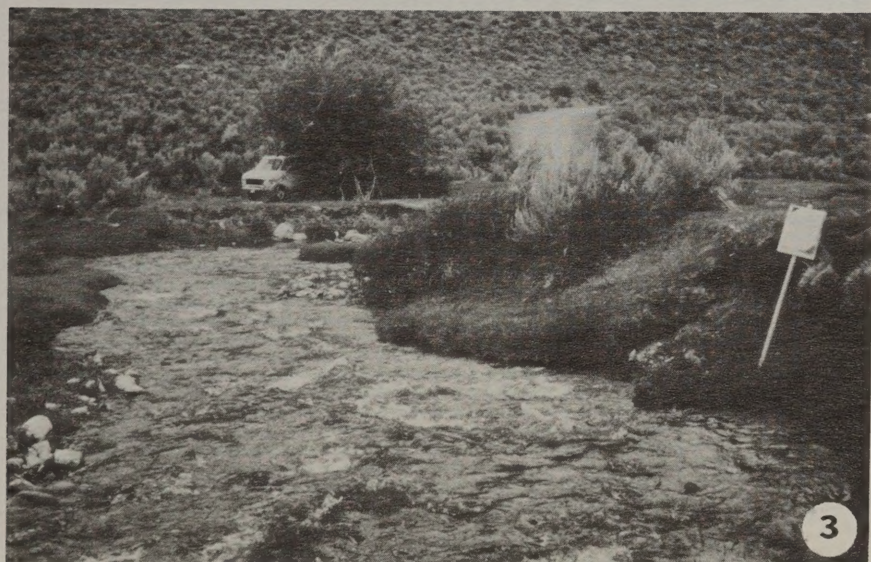
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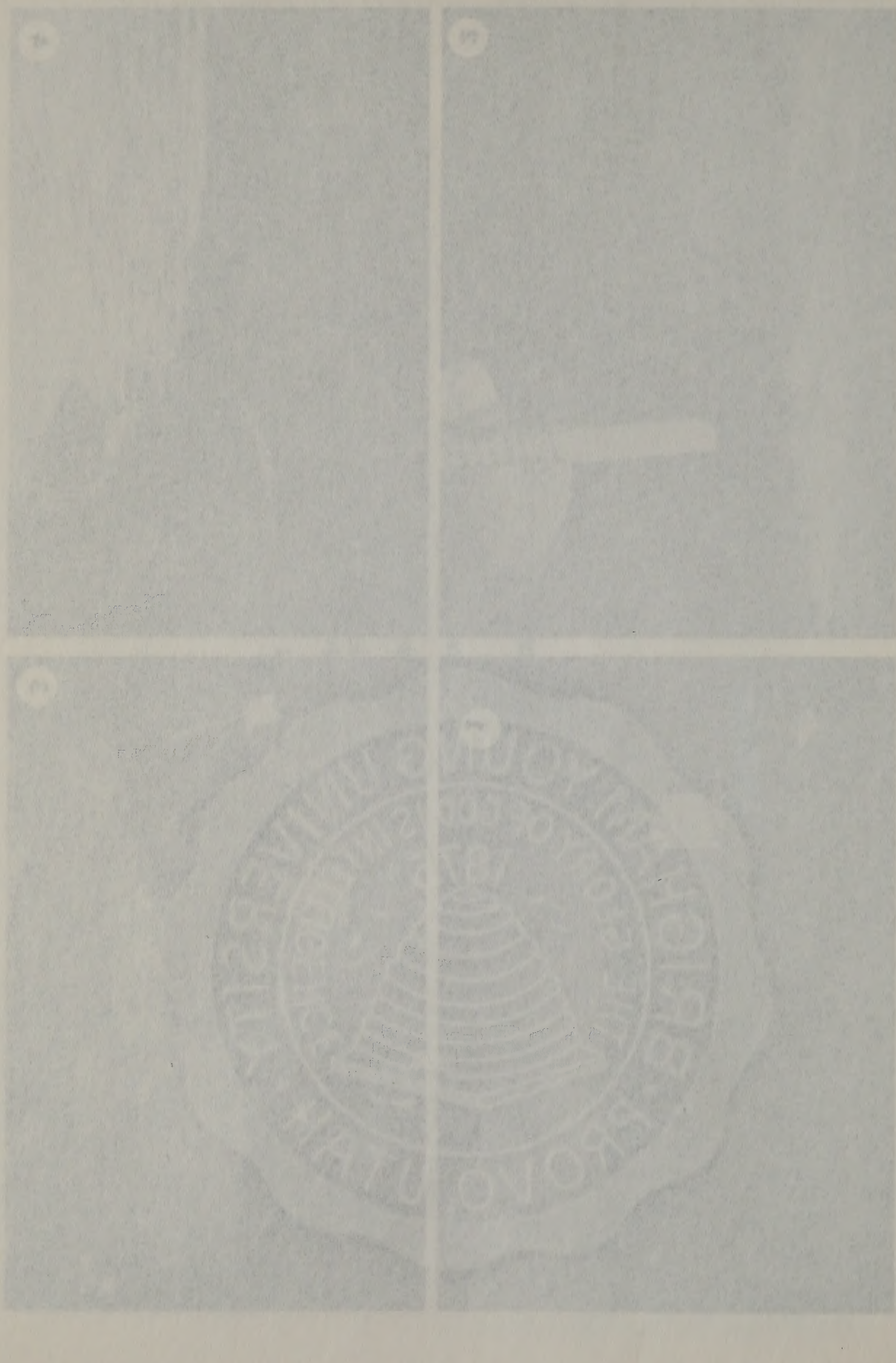

PLATE III

PICTURE 1. BIG CREEK AT SITE S-1 BELOW THE EXCLOSURE ON JUNE 17, 1975.

PICTURE 2. BIG CREEK AT SITE S-4, TRANSECT 3 ON AUGUST 21, 1975.

PICTURE 3. BIG CREEK AT SITE S-1 BELOW THE EXCLOSURE ON JUNE 17, 1975 SHOWING BANK INSTABILITY AND LACK OF RIPARIAN VEGETATION.

PICTURE 4. BIG CREEK WITHIN THE EXCLOSURE AT SITE S-2, TRANSECT 3 ON JUNE 17, 1975.

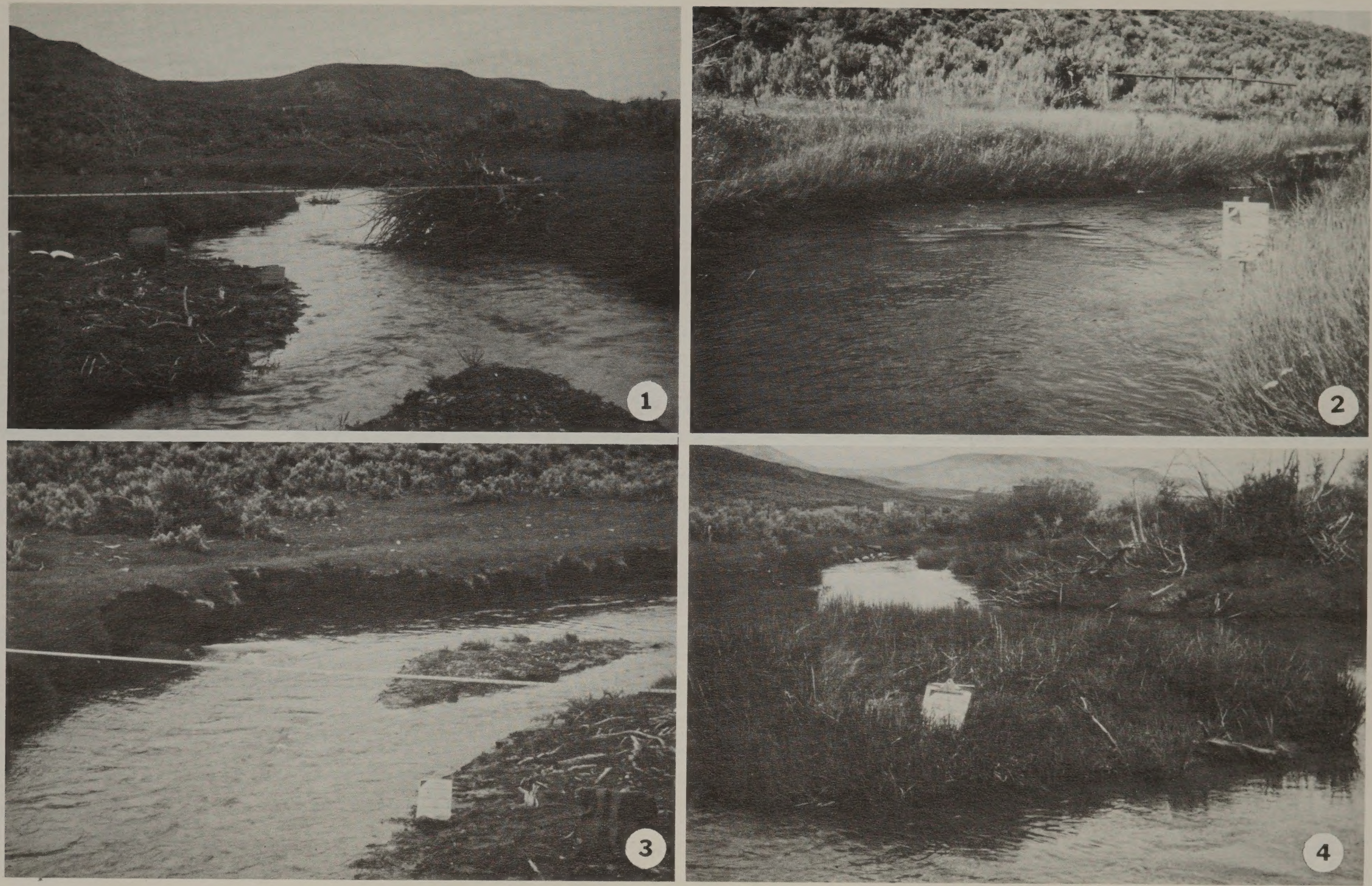
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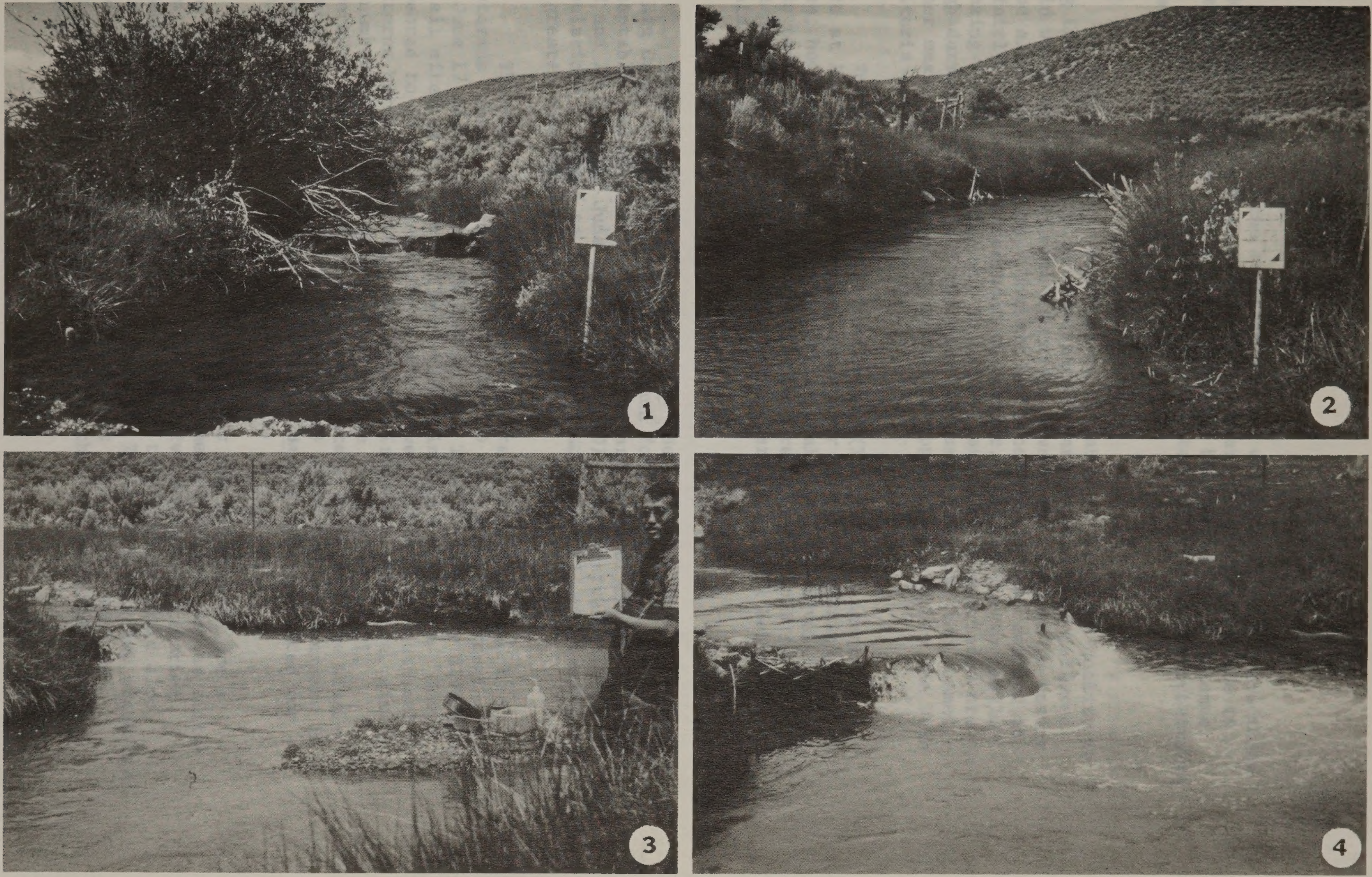
PLATE IV

PICTURE 1. BIG CREEK WITHIN THE EXCLOSURE AT SITE S-2, TRANSECT 3 SHOWING INCREASE IN RIPARIAN VEGETATION ON AUGUST 21, 1975.

PICTURE 2. BIG CREEK AT SITE S-3, TRANSECT 5, ON AUGUST 21, 1975 SHOWING INCREASED BANK STABILITY AND COVER.

PICTURE 3. BIG CREEK WITHIN THE EXCLOSURE ON JUNE 17, 1975 SHOWING POOL CREATED BY GABION STRUCTURE AT SITE S-3.

PICTURE 4. BIG CREEK SHOWING GABION AND RESULTANT POOL AT SITE S-2 WITHIN THE EXCLOSURE ON JUNE 17, 1975.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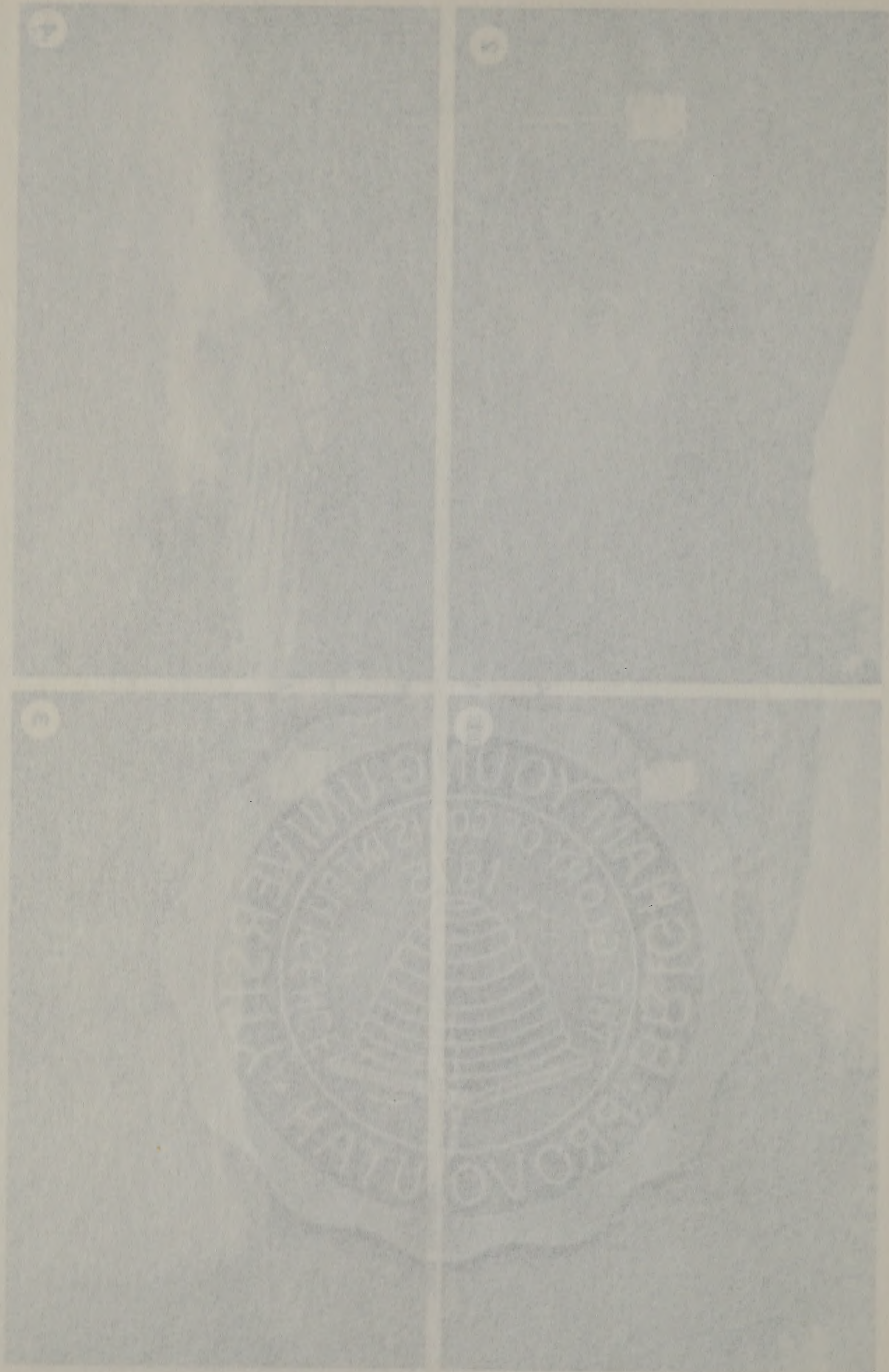

In summary, the riparian habitat was in much better condition inside the exclosure than outside; however, it is questionable if the total fisheries habitat has improved because of the imbalance in the riffle-pool ratio and high percentage of undesirable substrates (mean 35 percent).

Water quality. As observed in Table 4, the water quality in Big Creek is good. It is a moderately hard, bicarbonate buffered cold water mountain stream. Nutrient levels are adequate to ensure good algal productivity. Nitrate and phosphate levels remained at a fairly high level throughout the summer, probably due to cattle grazing in the bottomlands. In natural streams the nutrients are high during spring runoff and then decrease throughout the summer. Other measured water quality standards appear to be within the Utah criteria for Class CC waters.

Total and fecal coliform counts (Table 4) on August 21 were at low levels considering the number of cattle grazing in the area; however, on June 19, bacterial levels were relatively high. This could have resulted from rains and resultant runoff during the preceding two or three days. They were still well below the state standards for Class C waters.

Macroinvertebrate communities. Benthic sampling efficiency on Big Creek (Table 7) was analyzed and found to be well within acceptable limits with the percent standard error of the mean being 4.2 and 14.6 for 17 June and 21 August 1975, respectively. The populations appeared to be more clumped on August 21, thus resulting in greater variation among samples.

The benthic communities of Big Creek were dominated by dipterans (mostly Chironomidae) (Table 8) averaging 81 percent on June 17 and 51 percent on August 21. The low community diversity at all sites on 17 June reflects this chironomid dominance. There appeared to be no differences in macroinvertebrate distributional patterns between the sites outside and within the exclosure, either by numbers or biomass (Table 9 and Figure 7). By August 21, diversity values had increased at all sites, reflecting the simultaneous decrease in dipteran (chironomid) dominance and increase in numbers of ephemeropterans (mayflies). *Baetis* spp. accounted for about 95 percent of the mayfly dominance.

High, unstable numbers of baetids and chironomids are a good indication of some types of environmental stress such as siltation, and organic enrichment. The relative absence of riparian vegetation and resulting elevated summer temperatures could also be a limiting factor to benthic faunas. There were very few stoneflies (Plecoptera) in the system and those that were there, such as *Pteronarcella* sp. and *Isoperla* sp., are the more tolerant forms (Table 9).

In summary, the riparian habitat was in much better condition inside the enclosure than outside; however, it is questionable if the total fisheries habitat has improved because of the imbalance in the riffle-pool ratio and high percentage of undesirable substrates (mean 35 percent).

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Management alternatives. The exclosure has been effective in increasing bank stability and cover; however, too many dam-like fisheries improvement structures were built, resulting in a dominance of pools and a shortage of riffles. Any future improvements above or below the exclosure should limit the number of structures built.

It appears from the condition of the riparian habitat outside the exclosure that access of cattle to the stream needs to be limited to specified watering areas with a buffer zone established along the majority of the stream. A riparian buffer zone should be created along the stream in the more heavily used areas, eliminating livestock use in this zone except for cattle pass-ways or off-stream water deployment. Reseeding plus natural revegetation would greatly stabilize the banks, provide more cover and decrease daily mean water temperatures during the critical summer months.

Stream flows appear adequate at present, but minimum flows should be determined and no sub-minimal flows permitted.

The habitat inside the exclosure is still undergoing considerable change. In order to evaluate the continued effectiveness of the exclosures, this study should be continued, including aerial infra-red photography and vegetative mapping.

Table 1. Stream habitat survey summary and analysis for Big Creek on 21 August 1975.

1. State, County Utah, Rich	2. District Salt Lake	3. Resource Area--P.U. Wasatch--Randolph
4. Drainage Bear River	5. Stream Unit Big Creek	6. Location T. 10N R. 6E Sect. 19
7. Investigators Winget and Reichert		8. Date 21 August 1975

General Data

9. Total length of stream (mi.)	≈20
10. Total length of stream surveyed (mi.)	
a. BLM	1.5
b. Public	--
c. Private	--
11. Total No. sample stations:	
a. BLM	6
b. Public	
c. Private	
12. Total of all stream width measurements (ft.)	424
13. Total channel width (ft.)	680
14. Total width--all pools (ft.)	251
15. Total width of all pools classed 1, 2, and 3 (ft.)	220
16. Total footage of desirable bottom materials (ft.)	314
17. Total spawning gravels (ft.)	191
18. Sum of cover ratings	76
19. Sum of stability ratings	182
20. Elevation: (MSL)	
a. Lowest	6,594
b. Highest	6,610
21. Multiple use zones	water recreation agriculture
22. Number of camera points	
23. Total cost	
a. Planning	
b. Salaries	
c. Equipment	
d. Analysis of data	
24. Cost per station	

Priority A Limiting Factors

25. Percent of total stream width in pools	59%
26. Pool-riffle ratio, % optimum	82
27. Pool quality, % optimum	72
28. Percent of stream bottom with desirable materials	74
29. Percent spawning gravels	45
30. Bank cover, % optimum	32
31. Bank stability, % optimum	76
32. Percent of habitat optimum	67

Priority B Limiting Factors

33. Average depth of stream (ft.)	0.85
34. Average width of stream (ft.)	14
35. Average width of channel (ft.)	22.7
36. Percent of bottom with clinging vegetation (ft.)	trace
37. Percent of bottom with rooted vegetation (ft.)	≈1%
38. Percent stream shade	≈2%
39. Average stream gradient (%)	1%
40. Average stream velocity (f/s)	1.6
41. Stream discharge (cfs)	12.9
42. Average water temperature: (°F or °C)	14°C
43. Average Air Temperature (°F or °C)	21.3°C
44. Turbidity description (clear)	7 JTU
45. Access (mi.):	
a. Remote	
b. Low standard trails	
c. Improved trails	
d. Low standard roads	
e. Improved roads (graded)	10
46. Water quality analysis:	
a. Hach kit (pH, DO, CO_2, Tur., Spec. Con)	
b. Chemical (BYU)	X
c. Coli (BYU)	X

Table 2. Stream habitat survey summary and analysis for Big Creek for June 17, 1975.

1. State, County Utah, Rich	2. District Salt Lake	3. Resource Area--P.U. Wasatch--Randolph
4. Drainage Bear River	5. Stream Unit Big Creek	6. Location T. 10N R. 6E Sect. 19
7. Investigators Winget and Reichert		8. Date June 17, 1975

General Data	
9. Total length of stream (mi.)	≈20
10. Total length of stream surveyed (mi.)	
a. BLM	1.5
b. Public	--
c. Private	--
11. Total No. sample stations:	
a. BLM	5 phys. 6 benthos
b. Public	--
c. Private	--
12. Total of all stream width measurements (ft.)	415
13. Total channel width (ft.)	630
14. Total width--all pools (ft.)	252
15. Total width of all pools classed 1, 2, and 3 (ft.)	203
16. Total footage of desirable bottom materials (ft.)	247
17. Total spawning gravels (ft.)	135
18. Sum of cover ratings	82
19. Sum of stability ratings	117
20. Elevation: (MSL)	
a. Lowest	6,594
b. Highest	6,610
21. Multiple use zones	water recreation agriculture
22. Number of camera points	
23. Total cost	
a. Planning	
b. Salaries	
c. Equipment	
d. Analysis of data	
24. Cost per station	

Priority A Limiting Factors	
25. Percent of total stream width in pools	61%
26. Pool-riffle ratio, % optimum	78
27. Pool quality, % optimum	63
28. Percent of stream bottom with desirable materials	63
29. Percent spawning gravels	33
30. Bank cover, % optimum	39
31. Bank stability, % optimum	56
32. Percent of habitat optimum	60

Priority B Limiting Factors	
33. Average depth of stream (ft.)	0.9
34. Average width of stream (ft.)	16
35. Average width of channel (ft.)	24.2
36. Percent of bottom with clinging vegetation (ft.)	--
37. Percent of bottom with rooted vegetation (ft.)	≈1%
38. Percent stream shade	7
39. Average stream gradient (%)	≈2
40. Average stream velocity (f/s)	1.5
41. Stream discharge (cfs)	13.3
42. Average water temperature: (°F or °C)	10°C
43. Average Air Temperature (°F or °C)	13.6°C
44. Turbidity description (clear)	0 JTU
45. Access (mi.):	
a. Remote	
b. Low standard trails	
c. Improved trails	
d. Low standard roads	
e. Improved roads (graded gravel)	10
46. Water quality analysis?	
a. Hach kit	
b. Chemical (BYU)	X
c. Coli (USGS)	X

Table 3. Summary and analysis of riparian habitat outside and inside the exclosure on Big Creek on 17 June 1975 and 21 August 1975.

	17 June 1975		21 August 1975	
Priority A Limiting Factors	Outside Exclosure	Inside Exclosure	Outside Exclosure	Inside Exclosure
Percent of total stream width in pools	49%	69%	50%	72%
Pool-riffle ratio, % optimum	98%	62%	100%	56%
Pool quality, % optimum	70%	57%	97%	43%
Percent of stream bottom with desirable materials	63%	55%	76%	75%
Percent spawning gravels	47%	20%	53%	39%
Bank cover, % optimum	25%	50%	32%	32%
Bank stability, % optimum	35%	72%	63%	93%
Percent of habitat optimum	58%	59%	74%	60%
Priority B Limiting Factors				
Mean stream depth (ft)	0.62'	1.1'	0.78'	0.92'
Mean stream width (ft)	17.7'	14.6'	13.5'	14.1'
Mean channel width (ft)	28.7'	22.9'	23.4'	21.9'
Percent of bottom with clinging vegetation	0	0	0	<1%
Percent of bottom with rooted vegetation	0	0	0	≈1%
Percent stream shade	4%	11%	3%	8%
Mean stream gradient	≈1%	≈1%	1.2%	1.11%
Mean stream velocity (f/s)	1.48	1.4	1.73	1.46

Table 4. Water quality analysis of Big Creek.

Analysis* by	Test	17 June 1975 S-1	17 June 1975 S-3	17 June 1975 S-5	21 August 1975 S-1	21 August 1975 S-3	21 August 1975 S-6
	Time	0900	1220	1540	0830	1100	1330
1	Alkalinity, total as $CaCO_3$, mg/l	206	202	200	218	208	196
1	Bicarbonate as HCO_3, mg/l	208	226	224	251	239	233
1	Boron as B, mg/l	--	--	--	--	--	--
1	Calcium as Ca, mg/l	82	58	60	63	58	55
1	Carbonate as CO_3, mg/l	14	10	10	7	7	3
1	Chloride as Cl, mg/l	7	7	8	7	6	4
1, 3	Conductivity, μmhos/cm (25° C)	367	367	380	285	320	310
1	Hardness as $CaCO_3$, mg/l	292	238	195	230	221	208
1	Hydroxide as OH, mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
1	Magnesium as Mg, mg/l	21	22	11	17	18	17
3	pH	8.2	8.2	8.2	8.1	8.1	8.1
1	Potassium as K, mg/l	0.7	0.6	0.6	0.7	0.7	0.7
1	Sodium as Na, mg/l	6.3	5.8	5.8	5	5	4.8
1	Sulfate as SO_4, mg/l	8	7	7	6	6	5
1	Total Dissolved Solids	225	232	225	--	--	--
3	Turbidity, JTU's	1	1	1	10	5	5
3	Dissolved Oxygen as O_2, mg/l	9	9	9	9	9	9
1	Nitrate as N, mg/l	0.33	0.27	0.32	0.24	0.33	0.29
1	Phosphate (Total) as P, mg/l	0.025	0.021	0.004	0.013	0.026	0.017
1	Phosphate (ortho) as P, mg/l	0.025	0.021	<0.001	0.013	0.026	0.017
3	Air Temperature, °C	8	14	20	16	25	22
3	Water Temperature, °C	7	10	14	9	12	15
5, 1	Total Coliform, MPN/100 ml	930	930	930	43	75	23
5, 1	Fecal Coliform, MPN/100 ml	930	930	430	23	23	23

*1. BYU Environmental Analysis Laboratories
2. USGS
3. Field determinations
4. Bionics
5. Utah Department of Health and Welfare

Table 5. Big Creek water temperature data--daily minimum and maximum temperatures (°C) for June 18 to July 25, 1975.

Date	Min	Max	Date	Min	Max
June 18	--	9.5	July 7	10.5	19.0
19	5.0	8.5	8	10.5	20.0
20	3.0	9.0	9	11.0	18.0
21	6.0	12.0	10	10.5	19.0
22	5.5	18.5	11	10.5	16.0
23	6.5	14.0	12	10.0	14.0
24	6.5	15.0	13	9.5	19.5
25	8.0	11.5	14	10.5	18.5
26	4.5	15.0	15	11.0	19.0
27	5.5	15.5	16	10.5	14.0
28	6.5	16.0	17	8.5	16.0
29	6.5	17.0	18	10.0	19.0
30	6.5	17.0	19	10.0	19.0
July 1	7.0	17.5	20	10.5	17.0
2	8.5	18.5	21	9.5	18.5
3	10.0	12.5	22	10.5	19.0
4	9.0	19.5	23	10.0	18.0
5	10.5	18.0	24	9.5	18.0
6	9.5	19.0	25	10.0	18.5
15-day mean	11.8		15-day mean	14.0	

Table 6. Big Creek water temperature data--daily minimum and maximum temperatures (°C) for August 6 to September 11, 1975.

Date	Min	Max	Date	Min	Max
Aug. 6	10.0	18.5	Aug. 25	5.0	14.0
7	10.5	16.5	26	6.0	15.5
8	7.5	16.5	27	8.5	13.5
9	7.5	17.0	28	7.0	14.5
10	9.5	17.0	29	6.5	14.5
11	9.5	15.5	30	6.0	15.0
12	9.5	14.5	31	7.5	15.0
13	9.0	13.0	Sep. 1	7.0	13.5
14	8.5	14.0	2	5.5	14.0
15	9.0	16.0	3	5.0	14.0
16	7.5	15.5	4	6.0	14.0
17	8.5	16.0	5	5.5	14.5
18	8.5	16.0	6	6.0	14.5
19	7.0	14.0	7	5.0	14.0
20	8.0	12.0	8	6.0	14.5
21	7.5	15.5	9	6.0	13.5
22	8.5	15.0	10	10.0	11.0
23	8.0	14.5	11	8.0	11.5
24	7.5	14.0			
15-day mean	11.6		15-day mean	10.3	

Table 7. Statistics for stepwise pooled samples for Big Creek Site S-2 on 17 June 1975 and 21 August 1975.

Step*	Total No. of Taxa	Mean No/ft^2	80% Confidence Limits LL	80% Confidence Limits UL	Standard Deviation	Percent SE of Mean	Coefficient of Variation	$\bar{d}$	H
17 June 1975									
1	23	undefined	undefined	undefined	undefined	undefined	undefined	1.93	1.91
2	25	4,624.0	4,313.1	4,934.9	142.8	2.2	3.1	1.74	1.72
3	25	4,756.3	4,483.6	5,029.1	250.5	3.0	5.3	1.82	1.80
4	28	4,987.0	4,573.7	5,400.3	504.6	5.1	10.1	1.98	1.96
5	29	5,063.6	4,741.8	5,385.4	469.4	4.2	9.3	1.98	1.96
21 August 1975									
1	22	undefined	undefined	undefined	undefined	undefined	undefined	2.26	2.24
2	28	3,800.0	-503.0	8,103.0	1,977.1	36.8	52.0	2.31	2.29
3	28	4,056.3	2,459.2	5,653.5	1,466.8	20.9	36.2	2.63	2.60
4	28	4,154.2	3,160.4	5,148.1	1,213.6	14.6	29.2	2.57	2.54

*Step 1 consists of only one sample; Step 2 is the results from 2 pooled samples; Step 3 is the results from 3 pooled samples, etc.

Table 8. Summary of macroinvertebrate community analysis for Big Creek on 17 June 1975 and 21 August 1975.

Sampling Site	Number of Taxa	Total $\bar{X}$ Number/m^2	% Ephemeroptera	% Plecoptera	% Trichoptera	% Coleoptera	% Diptera	% Other Invertebrates	$\bar{d}$	H
S-1										
17 June 1975	26	48,850	3	1	2	2	80	12	1.52	1.50
21 August 1975	27	39,683	19	2	13	5	45	16	2.95	2.93
S-2										
17 June 1975	30	54,521	3	1	2	5	68	22	1.98	1.96
21 August 1975	28	44,708	9	1	4	4	50	31	2.57	2.54
S-3										
17 June 1975	27	38,628	2	0.5	1	1	92	4	0.81	0.79
21 August 1975	29	41,405	8	1	13	2	60	16	2.43	2.41
S-4										
17 June 1975	31	40,415	4	1	1	2	87	5	1.17	1.15
21 August 1975	31	28,406	14	2	11	5	54	15	2.99	2.95
S-5										
17 June 1975	28	21,412	3	1	1	1	91	3	1.01	0.97
21 August 1975	28	25,189	12	4	16	3	53	12	2.67	2.63
S-6										
17 June 1975	30	46,548	3	1	2	5	69	21	1.84	1.82
21 August 1975	29	50,830	13	1	12	3	41	30	2.69	2.67

Table 9. Number per meter square of macroinvertebrate taxa collected from Big Creek.

Taxa	17 June 1975						21 August 1975					
	S-1	S-2	S-3	S-4	S-5	S-6	S-1	S-2	S-3	S-4	S-5	S-6
Phylum Aschelminthes												
Class Nematoda	603	979	118	97	108	764	54	108	75	355	301	1,506
Phylum Mollusca												
Class Pelecypoda	11	11	0	0	11	0	11	43	86	65	43	0
Class Gastropoda	0	0	0	0	0	0	0	43	129	161	108	22
Phylum Annelida												
Class Oligochaeta	4,035	8,812	947	882	215	7,693	5,036	5,552	12,514	3,314	2,529	13,525
Phylum Arthropoda												
Class Arachnida												
Order Acarina												
Suborder Hydracarina	1,851	3,314	484	1,324	409	2,055	1,420	1,205	1,410	872	495	1,991
Class Crustacea												
Order Ostracoda	43	22	0	11	0	22	32	11	97	97	215	65
Order Copepoda	0	118	22	22	22	65	11	0	11	0	0	0
Order Amphipoda	0	0	0	0	0	0	0	0	11	0	0	0
Order Decapoda	0	11	0	0	0	0	11	11	11	0	11	11
Class Insecta												
Order Collembola	11	0	0	0	0	0	0	0	0	0	0	0
Family Poduridae	0	22	0	0	0	0	0	0	0	0	0	0
Podura aquatica	0	0	0	0	11	0	0	0	0	0	0	0
Family Sminthuridae	0	22	0	0	0	0	0	0	0	0	0	0
Order Ephemeroptera												
Family Siphlonuridae												
Ameletus sp.	0	11	0	11	11	0	0	0	11	0	0	0
Family Baetidae												
Baetis spp.	118	97	86	75	54	129	3,669	1,722	2,153	1,980	1,786	5,595
Family Heptageniidae												
Heptagenia sp.	0	0	0	0	0	0	32	34	54	11	43	0
Cinygmula spp.	75	43	11	11	0	11	0	0	0	0	0	0
Epeorus sp.	0	11	0	0	0	0	0	0	0	0	0	11
Other Heptageniidae	22	0	0	32	32	65	0	0	0	0	0	11
Family Leptophlebiidae												
Paraleptophlebia sp.	86	194	65	75	11	290	344	204	484	129	151	172
Family Ephemerellidae												
Ephemerella sp.	377	613	215	570	129	301	538	430	495	839	140	140
Ephemerella inermis	581	140	183	248	301	183	54	161	140	194	452	64
Ephemerella grandis	398	258	161	581	139	301	3,045	645	775	667	441	678
Ephemerella margarita	0	0	0	0	0	0	11	0	65	0	0	0
Ephemerella tibialis	0	0	0	0	0	11	0	22	0	11	11	11
Family Tricorythidae												
Tricorythodes sp.	0	0	0	0	0	0	0	22	0	11	0	0
Other Ephemeroptera	0	32	22	11	22	22	0	0	0	11	0	0
Order Plecoptera												
Family Nemouridae	0	11	0	0	11	0	0	0	0	0	0	0
Family Pteronarcidae												
Pteronarcella sp.	420	280	129	238	86	226	226	75	108	172	387	172

Table 9. (continued)

Taxa	17 June 1975 S-1	S-2	S-3	S-4	S-5	S-6	21 August 1975 S-1	S-2	S-3	S-4	S-5	S-6
Family Perlodidae												
Skwala parallela	0	0	0	0	0	0	22	11	32	11	75	32
Isoperla fulva	0	A	0	0	A	0	0	0	0	0	0	0
Isoperla patricia	0	0	0	0	0	0	0	11 (A)	A	0	0	A
Isoperla sp.	43	43	11	22	11	32	334	355	377	517	463	312
Family Chloroperlidae	0	11	11	11	11	32	54	0	0	0	54	22
Other Plecoptera	22	32	22	43	32	11	0	0	33	0	11	0
Order Trichoptera												
Family Rhyacophilidae												
Rhyacophila spp.	22	86	11	0	11	236	0	54	43	0	0	161
Family Glossosomatidae												
Agapetus sp.	0	0	0	0	0	11	0	0	0	0	11	0
Family Hydropsychidae												
Hydropsyche spp.	248	818	86	280	43	108	1,011	484	861	11	54	32
Arctopsyche spp.	11	11	0	11	0	11	75	22	11	226	65	301
Other Hydropsychidae	0	0	0	0	0	0	215	0	0	172	0	75
Family Hydroptilidae	0	0	0	0	0	0	0	0	0	0	0	65
Family Limnephilidae	32	32	0	11	0	32	11	32	11	151	11	0
Limnephilus sp.												
Ecclisomyia sp.												
Family Lepidostomatidae	11	0	0	0	0	0	0	0	0	0	0	0
Family Brachycentridae												
Brachycentrus sp.	215	11	22	75	108	11	3,938	4,713	753	2,529	3,831	5,391
Micrasema sp.	0	0	0	0	0	0	0	0	0	11	0	0
Other Trichoptera	387	183	204	11	154	43	11	0	0	0	0	0
Order Coleoptera												
Family Elmidae	775	2,486	258	742	312	2,334	1,764	785	1,878	1,302	710	1,420
Family Dryopidae												
Dryops sp.	0	0	11	0	0	0	0	0	0	0	0	0
Family Dytiscidae	0	0	0	0	0	0	22	32	86	11	64	0
Family Gyrinidae	0	0	0	11	0	0	0	0	0	0	0	0
Family Curculionidae	0	0	0	0	0	0	0	0	11	11	0	0
Family Haliplidae	0	0	0	0	0	0	0	0	0	11	0	0
Other Coleoptera	0	0	0	0	0	0	0	11	0	0	0	0
Order Diptera												
Family Tipulidae												
Antocha monticola	118	742	11	75	22	398	409	581	1,926	312	22	796
Dicranota sp.	0	11	0	0	0	32	0	0	0	0	0	11
Hexatoma sp.	409	269	654	495	441	172	452	506	591	1,636	721	409
Holorusia grandis	0	0	11	11	11	11	0	0	0	0	11	0
Other Tipulidae	0	11	22	11	0	0	11	22	11	11	0	0
Family Psychodidae	0	0	0	0	11	0	0	0	0	0	0	0
Family Simuliidae	796	1,410	118	0	0	0	238	882	172	721	204	0
Simulium sp.	0	0	0	301	108	118	0	0	0	0	0	807
Family Chironomidae	37,682	34,346	34,830	34,195	18,776	30,677	16,376	22,671	19,616	12,471	12,320	18,367
Family Ceratopogonidae	0	0	32	11	0	0	0	0	0	11	0	0
Family Stratiomyidae												
Euparyphus sp.	0	0	0	11	0	0	0	11	0	0	0	11
Family Tabanidae	0	0	0	0	0	0	0	0	11	0	0	0
Family Empididae	108	204	11	32	32	634	366	129	151	54	118	226
Other Diptera	11	0	0	0	11	0	0	0	0	32	11	22

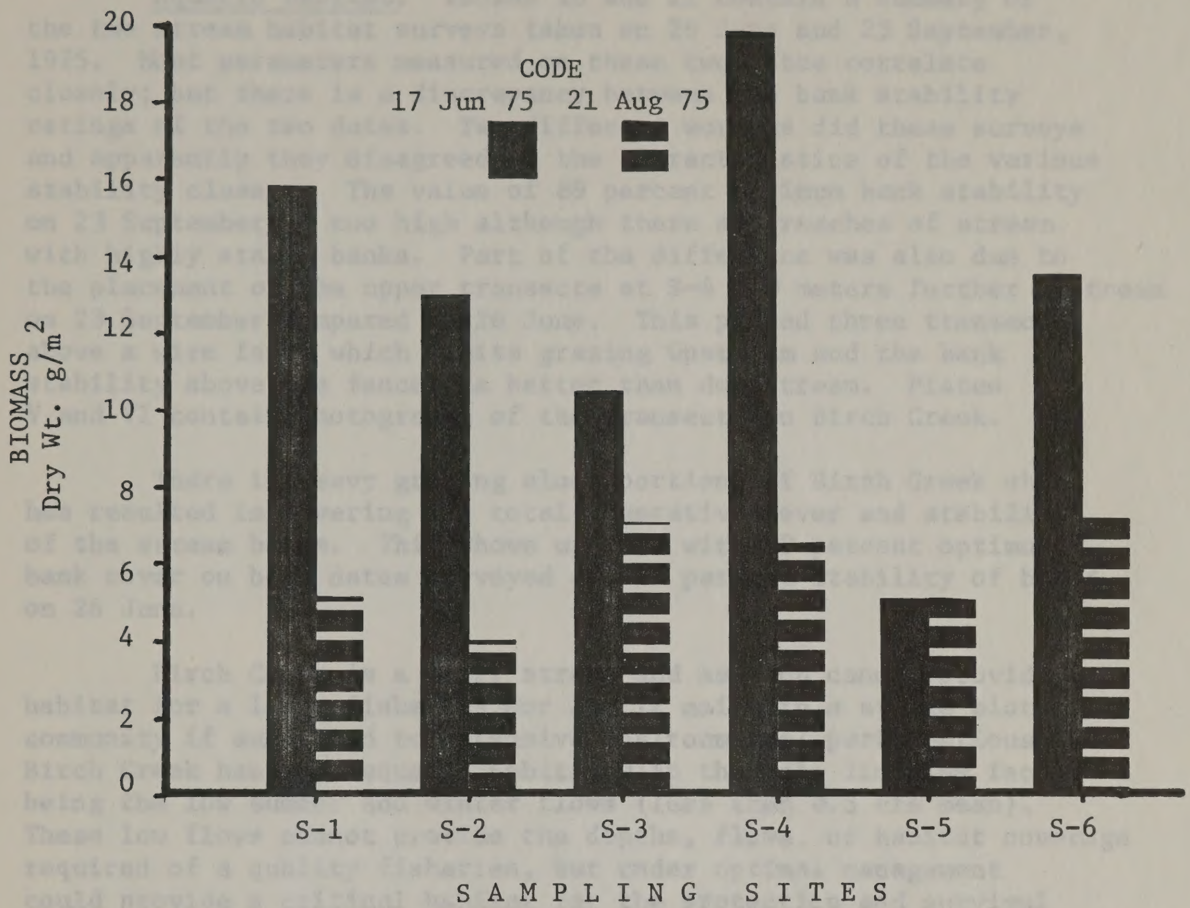


Figure 7. Comparison of macroinvertebrate standing crop (biomass) at six sites on Big Creek on 17 June 1975 and 21 August 1975.

Birch Creek

Aquatic habitat. Tables 10 and 11 contain a summary of the two stream habitat surveys taken on 26 June and 23 September, 1975. Most parameters measured on these two dates correlate closely; but there is a discrepancy between the bank stability ratings of the two dates. Two different workers did these surveys and apparently they disagreed on the characteristics of the various stability classes. The value of 89 percent optimum bank stability on 23 September is too high although there are reaches of stream with highly stable banks. Part of the difference was also due to the placement of the upper transects at S-4 100 meters further upstream on 23 September compared to 26 June. This placed three transects above a wire fence which limits grazing upstream and the bank stability above the fence was better than downstream. Plates V and VI contain photographs of the transects on Birch Creek.

There is heavy grazing along portions of Birch Creek which has resulted in lowering the total vegetative cover and stability of the stream banks. This shows up best with 59 percent optimum bank cover on both dates surveyed and 59 percent stability of banks on 26 June.

Birch Creek is a small stream and as such cannot provide habitat for a large fisheries nor can it maintain a stable biotic community if subjected to extensive environmental perturbations. Birch Creek has good aquatic habitat with the main limiting factor being the low summer and winter flows (less than 0.5 cfs mean). These low flows cannot provide the depths, flows, or habitat coverage required of a quality fisheries, but under optimal management could provide a critical habitat for the protection and survival of a pure strain wild trout fishery.

Water quality. Birch Creek is a moderately soft water, bicarbonate buffered, clear cold-water mountain stream (Table 12). Nutrients are adequate for production of a good algal community with nitrate nitrogen at S-1 ranging from 0.23 mg/l on 26 June to 0.08 on 23 September 1975 and orthophosphate at 0.07 mg/l on both dates. Nitrate and phosphate concentrations are not excessive.

Bacteria samples indicate significant levels of total and fecal coliform, but they were still well below the state maximum for Class C waters (Table 12). On 26 June 1975, there were numerous cattle at S-1 which could account for the 400/100 ml total coliform, 220/100 ml fecal coliform, and 155/100 ml fecal streptococci at this station. At S-4 counts were considerably lower with only 167/100 ml total and 42/100 ml fecal coliforms. There were fewer animal signs at S-4, but there were some beaver ponds upstream. On 23 September levels were higher at S-4, probably the result of cattle being moved higher on the mountain as the summer progressed. The sample from S-1 in September was destroyed in transport.

PLATE V

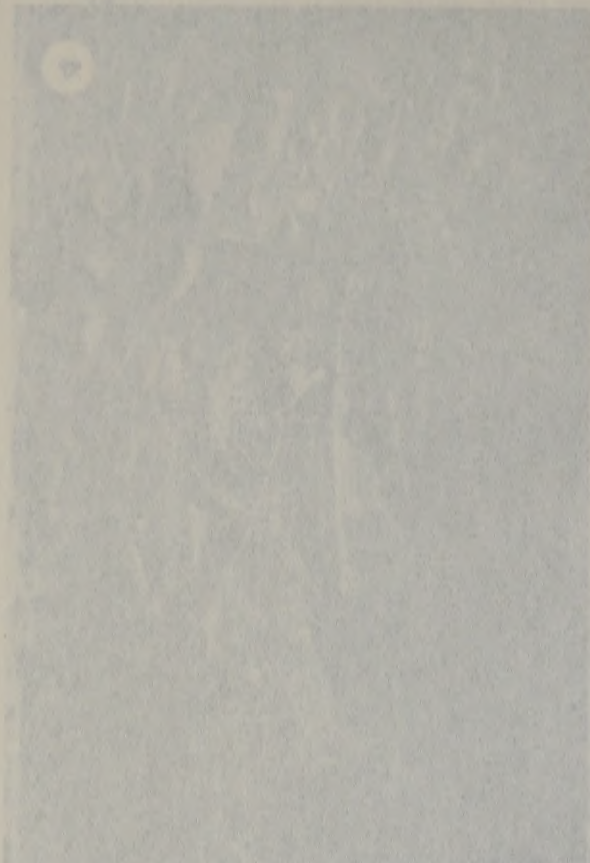
PICTURE 1. BIRCH CREEK AT SITE S-1 BURN AREA ON JUNE 26, 1975.

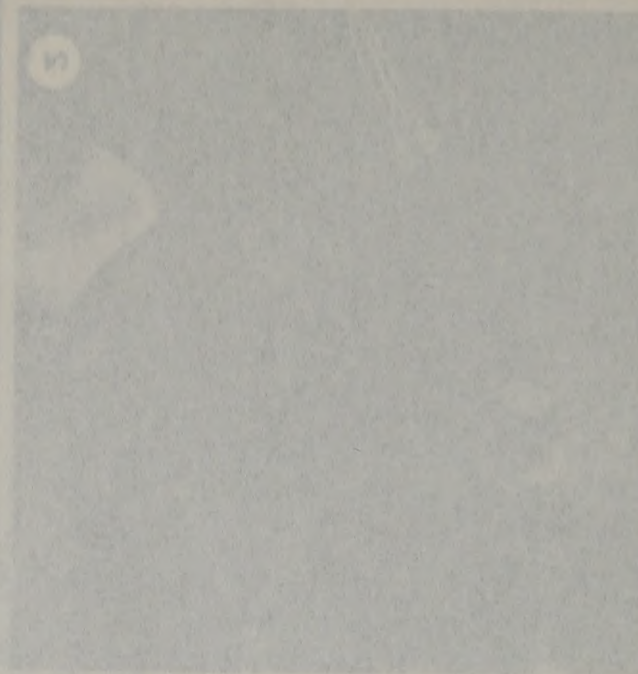
PICTURE 2. BIRCH CREEK SUBSTRATE AT S-1, TRANSECT 1 ON JUNE 26, 1975.

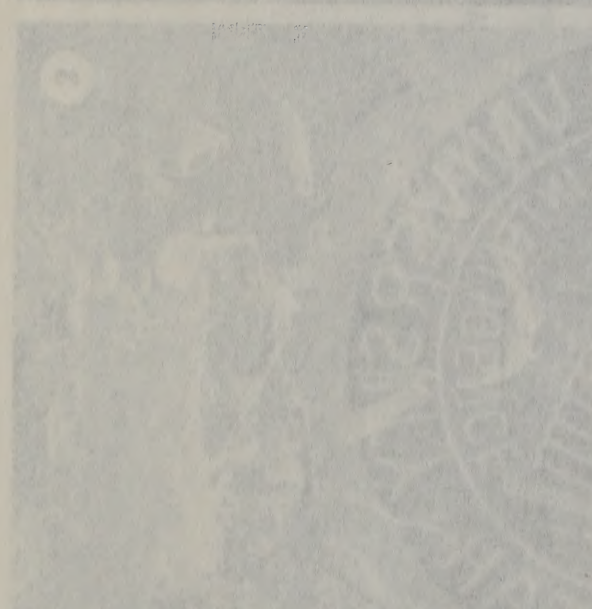
PICTURE 3. BIRCH CREEK AT SITE S-2, TRANSECT 1 ON JUNE 26, 1975.

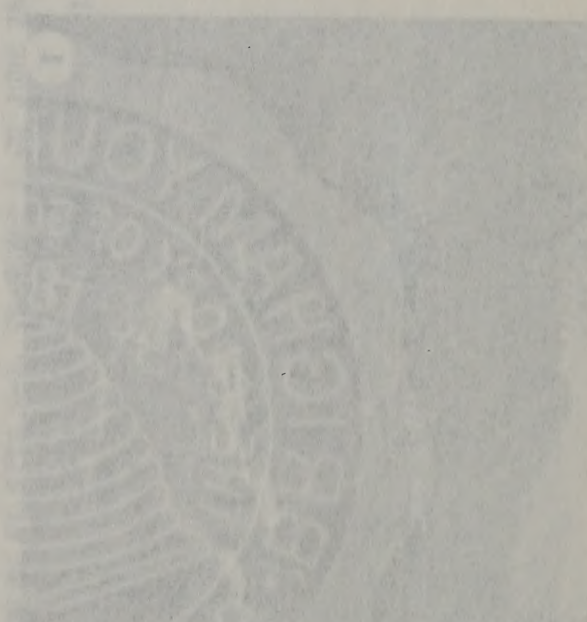
PICTURE 4. BIRCH CREEK AT SITE S-2, TRANSECT 4, AT THE FISHLAKE FOREST BOUNDARY ON JUNE 26, 1975.


1
2
3
4









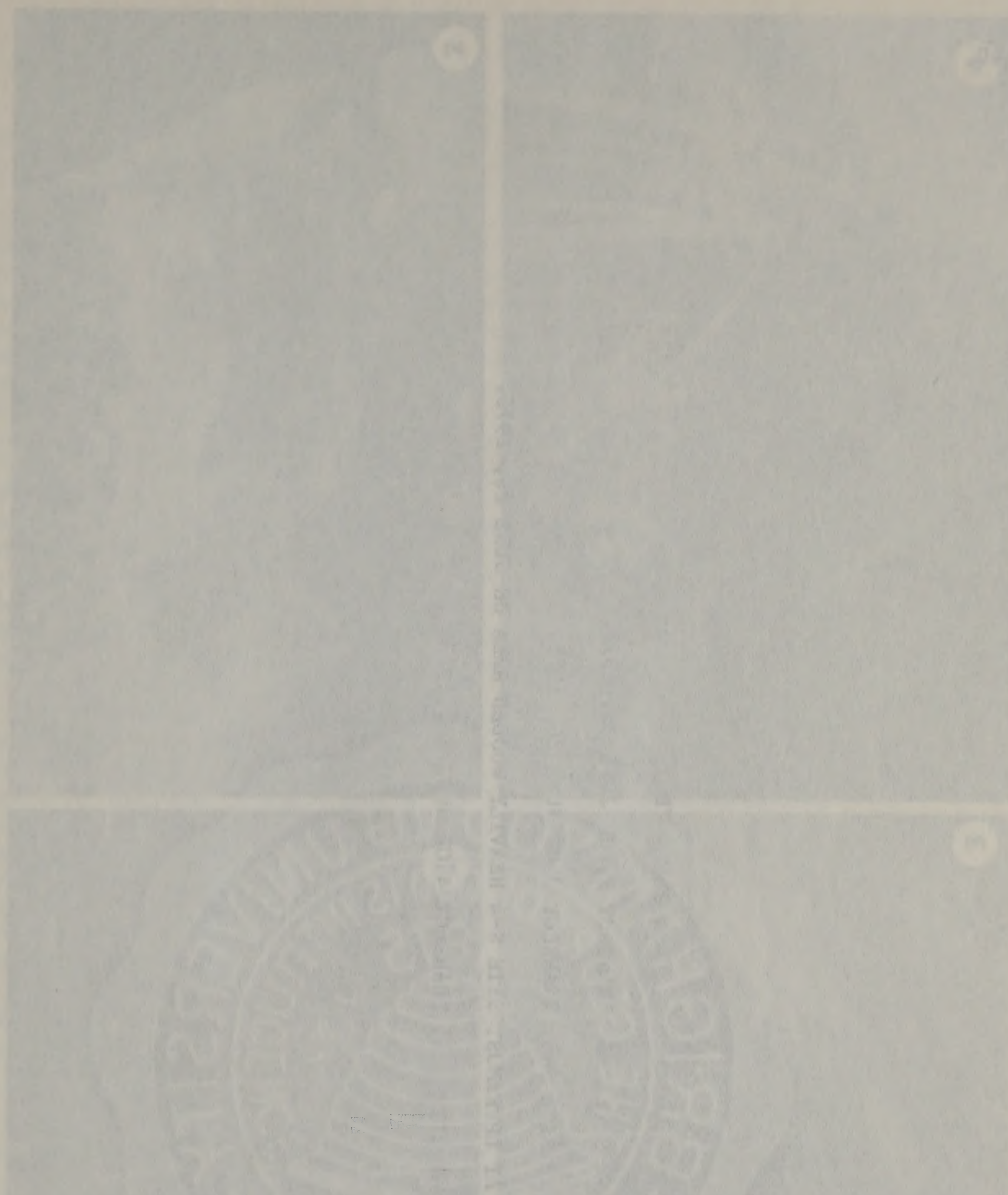


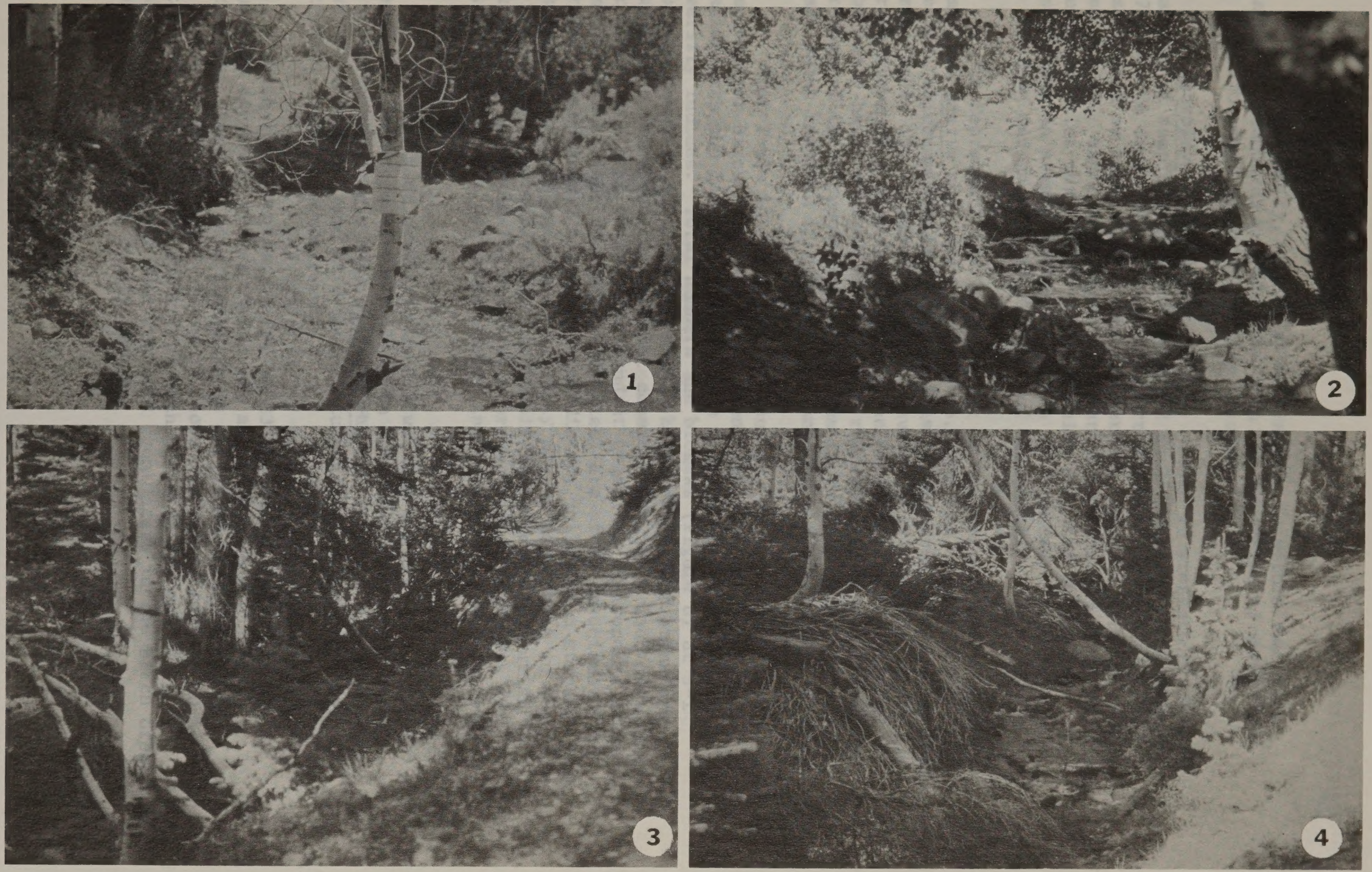
PLATE VI

PICTURE 1. BIRCH CREEK AT SITE S-3, TRANSECT 1, ON JUNE 26, 1975.

PICTURE 2. BIRCH CREEK AT SITE S-3, TRANSECT 3 ON JUNE 26, 1975.

PICTURE 3. BIRCH CREEK AT UPPERMOST SITE S-4 HEAVILY WOODED AREA ON JUNE 26, 1975.

PICTURE 4. BIRCH CREEK AT SITE S-4, TRANSECT 4 ON JUNE 26, 1975.



Water quality, as far as determined, is within the state Class "CC" standards and adequate with the exception of quantity of water for most aquatic organism groups.

Macroinvertebrate communities. Table 13 presents a step analysis of sample statistics from S-2 on 26 June and 23 September 1975. On 26 June 1975, the macroinvertebrates were fairly evenly distributed as indicated by the low percent standard error of the mean (16.7), and coefficient of variation (33.4); but on 23 September the communities were highly clumped which resulted in the wide discrepancy in sample estimates with a 49.1 percent standard error of the mean and an 85.1 coefficient of variation.

In September, the main element of variation within samples came from Baetis spp. and Cinygmula sp. mayflies, elmid riffle beetles, chironomid midges, water mites (Hydracarina), and oligochaete worms (Table 15). Clustering could have been in response to the low stream flows (0.3 cfs) compared to June (0.8 cfs). This reduced flow would have resulted in a serious reduction in suitable habitat for some of these species, forcing them to crowd together in small areas which resulted in a larger variance in numbers between samples.

From Table 14, which gives a summary of macroinvertebrate samples from Birch Creek, it is apparent that S-1 is the poorest station with the lowest number of taxa and the lowest dominance diversity indices. Total numbers and biomass (Figure 8) at S-1 are good compared to the other sites, but the dominant organisms (Table 15), elmid beetles, are not considered quality food organisms for fish. The next three most abundant organisms (chironomid midges, simuliid blackflies, and baetid mayflies) are often associated with stressed communities, especially immediately following a stress. They are active drifters and are continually moving downstream in search of new areas of suitable habitat. Their reproduction potential is astounding; and following a hatch, there are often in excess of 25,000 young larvae per square meter in small brook areas, generally at upstream sites.

The dominant caddisfly at S-1 was Hydropsyche sp., one of the more tolerant caddisflies, but one requiring a stable substrate on which to attach its net. Hydropsyche sp. builds a net which it uses for attachment and as a food capturing device for trapping materials floating downstream.

With the exception of S-1 on 23 September, the $\bar{d}$ and H dominance diversity values (Table 14) are good with S-4 near excellent. There is good diversity at all sites with from 21 to 28 taxa sampled per site. Table 15 shows a complete list of taxa collected with relative numbers of each per site for each date. Many of these have never been reported from waters in the Birch Creek area, and some are new county records.

S-4 has lower total numbers and biomass than S-1 or S-3. This is in direct response to the dense growths of evergreens along the stream which have out-competed the deciduous plants for space and light. The removal of deciduous plants has reduced one of the major food sources for many species. Also, the thick canopy restricts sunlight to the stream which limits algal growth, another major food source for several species of macroinvertebrates. Streams in evergreen forest areas have characteristically lower production of macroinvertebrates than comparable streams in deciduous forests.

Birch Creek has the potential of supporting a quality aquatic system with the present major threats being from minimum flows and overgrazing of stream banks by livestock.

Management alternatives. Birch Creek has several management alternatives open to it. The approach depends upon the value set on it as a fisheries habitat. It is a small stream and as such will never be able to maintain a fisheries for harvest purposes. This means that a fisheries in Birch Creek will be mainly for maintaining the pure strain Utah cutthroat trout currently existing there but threatened by limited habitats in the intermountain area.

Management of aquatic habitat by federal land agencies should include:

1. Limited grazing on riparian vegetation, particularly grasses, to insure bank stability and stream cover;

2. Guaranteed minimum stream flows such as no diversion of water during periods of low flow;

3. Pool quality improvement such as increasing depth and cover of selected pools. Riffle habitats are of high quality with little sedimentation of interstitial spaces;

4. Management or elimination of existing beaver populations by the Utah Division of Wildlife Resources to prevent further degradation or elimination of critical limited riparian habitats, siltation of desirable stream substrate, and blockage of fish migrations; and

5. Continued surveillance of water and habitat quality, including macroinvertebrate sampling and vegetation mapping.

Table 10. Stream habitat survey summary and analysis for Birch Creek on 26 June 1975.

1. State, County Utah, Beaver	2. District Cedar City	3. Resource Area--P.U. Beaver River--Beaver River
4. Drainage Beaver River	5. Stream Unit Birch Creek	6. Location T. 30S R. 6W Sect. 6
7. Investigators Winget and Reichert		8. Date June 26, 1975

General Data

9. Total length of stream (mi.)	≈10
10. Total length of stream surveyed (mi.)	
a. BLM	2
b. Public (USFS)	2
c. Private	--
11. Total No. sample stations:	
a. BLM	2
b. Public (USFS)	2
c. Private	--
12. Total of all stream width measurements (ft.)	76
13. Total channel width (ft.)	227
14. Total width--all pools (ft.)	31
15. Total width of all pools classed 1, 2, and 3 (ft.)	20
16. Total footage of desirable bottom materials (ft.)	55
17. Total spawning gravels (ft.)	34
18. Sum of cover ratings	75
19. Sum of stability ratings	76
20. Elevation: (MSL)	
a. Lowest	7,060
b. Highest	7,800
21. Multiple use zones	cattle grazing recreation
22. Number of camera points	
23. Total cost	
a. Planning	
b. Salaries	
c. Equipment	
d. Analysis of data	
24. Cost per station	

Priority A Limiting Factors

25. Percent of total stream width in pools	41%
26. Pool-riffle ratio, % optimum	82
27. Pool quality, % optimum	53
28. Percent of stream bottom with desirable materials	72
29. Percent spawning gravels	45
30. Bank cover, % optimum	59
31. Bank stability, % optimum	59
32. Percent of habitat optimum	65

Priority B Limiting Factors

33. Average depth of stream (ft.)	0.26
34. Average width of stream (ft.)	4.75
35. Average width of channel (ft.)	14.2
36. Percent of bottom with clinging vegetation (ft.)	≈10
37. Percent of bottom with rooted vegetation (ft.)	≈2
38. Percent stream shade	48
39. Average stream gradient (%)	4.3
40. Average stream velocity (f/s)	0.72
41. Stream discharge (cfs)	0.90
42. Average water temperature: (°F or °C)	12° C
43. Average Air Temperature (°F or °C)	21° C
44. Turbidity description (clear)	3 JTU
45. Access (mi.):	
a. Remote	
b. Low standard trails	
c. Improved trails	
d. Low standard roads	8
e. Improved roads	
46. Water quality analysis:	
a. Hach kit (pH, DO, tur., CO_2, Spec. Con)	
b. Chemical (BYU)	X
c. Coli (Bionics)	X

Table 11. Stream habitat survey summary and analysis for Birch Creek on 23 September 1975.

1. State, County Utah, Beaver	2. District Cedar City	3. Resource Area--P.U. Beaver River--Beaver River
4. Drainage Beaver River	5. Stream Unit Birch Creek	6. Location T. 30S R. 6W Sect. 6
7. Investigators Reichert and Cluff		8. Date 23 September 1975

General Data

9. Total length of stream (mi.)	≈10
10. Total length of stream surveyed (mi.)	
a. BLM	2
b. Public (USFS)	2
c. Private	--
11. Total No. sample stations:	
a. BLM	2
b. Public (USFS)	2
c. Private	--
12. Total of all stream width measurements (ft.)	69
13. Total channel width (ft.)	244
14. Total width--all pools (ft.)	24.5
15. Total width of all pools classed 1, 2, and 3 (ft.)	20.5
16. Total footage of desirable bottom materials (ft.)	63
17. Total spawning gravels (ft.)	49
18. Sum of cover ratings	95
19. Sum of stability ratings	143
20. Elevation: (MSL)	
a. Lowest	7,060
b. Highest	7,800
21. Multiple use zones	cattle grazing recreational
22. Number of camera points	12
23. Total cost	
a. Planning	
b. Salaries	
c. Equipment	
d. Analysis of data	
24. Cost per station	

Priority A Limiting Factors

25. Percent of total stream width in pools	36%
26. Pool-riffle ratio, % optimum	72
27. Pool quality, % optimum	60
28. Percent of stream bottom with desirable materials	91
29. Percent spawning gravels	71
30. Bank cover, % optimum	59
31. Bank stability, % optimum	89
32. Percent of habitat optimum	74

Priority B Limiting Factors

33. Average depth of stream (ft.)	0.18
34. Average width of stream (ft.)	3.5
35. Average width of channel (ft.)	12.5
36. Percent of bottom with clinging vegetation (ft.)	≈1%
37. Percent of bottom with rooted vegetation (ft.)	<1
38. Percent stream shade	55
39. Average stream gradient (%)	5
40. Average stream velocity (f/s)	0.94
41. Stream discharge (cfs) (S-1 = 0.27, S-4 = 0.44)	$\bar{x}$ = 0.36
42. Average water temperature: (°F or °C)	9.6° C
43. Average Air Temperature (°F or °C)	21° C
44. Turbidity description (Range: 2-40 JTU)	14.5 JTU
45. Access (mi.):	
a. Remote	
b. Low standard trails	
c. Improved trails	
d. Low standard roads	8
e. Improved roads	
46. Water quality analysis:	
a. Hach kit (pH, DO, CO_2, Tur., Spec. Con)	
b. Chemical (BYU)	X
c. Coli (BYU)	X

Table 12. Water quality analysis of Birch Creek.

Analysis* by	Test	26 June 1975 S-1	26 June 1975 S-4	23 September 1975 S-1	23 September 1975 S-4
	Time	0950	1715	0830	1500
1	Alkalinity, total as $CaCO_3$, mg/l	61	56	62	45
1	Bicarbonate as HCO_3^-, mg/l	74	68	76	55
1	Boron as B, mg/l	--	--	--	--
1	Calcium as Ca, mg/l	13	12	16	11
1	Carbonate as CO_3, mg/l	<0.1	<0.1	<0.1	<0.1
1	Chloride as Cl, mg/l	1	1	1	<1
3	Conductivity, μmhos/cm (25° C)	88	87	90	80
1	Hardness as $CaCO_3$, mg/l	113	107	97	45
1	Hydroxide as OH, mg/l	<0.1	<0.1	<0.1	<0.1
1	Magnesium as Mg, mg/l	19	19	14	4
3	pH	7.9	7.6	7.6	7.6
1	Potassium as K, mg/l	2.7	2.5	2.5	2.3
1	Sodium as Na, mg/l	4.7	4.5	4.9	4
1	Sulfate as SO_4, mg/l	13	10	8	7
1	Total Dissolved Solids	118	118	123	99
3	Turbidity, JTU's	clear	3	12	4
3	Dissolved Oxygen as O_2, mg/l	--	8.0	10	9
1	Nitrate as N, mg/l	0.23	0.22	0.08	0.06
1	Phosphate (Total) as P, mg/l	0.070	0.055	--	--
1	Phosphate (Ortho) as P, mg/l	0.070	0.055	0.072	0.052
3	Air Temperature, °C	19.0	--	18	22
3	Water Temperature, °C	8.5	13.0	5	9.5
4, 1	Total Coliform, MPN/100 ml	400	167	--	460
4, 1	Fecal Coliform, MPN/100 ml	220	42	--	23

*1. BYU Environmental Analysis Laboratories
2. USGS
3. Field determinations
4. Bionics
5. Utah Department of Health and Welfare

Table 13. Statistics for stepwise pooled samples for Birch Creek Site S-2 on 26 June 1975 and 23 September 1975.

Step*	Total No. of Taxa	Mean No/ft^2	80% Confidence Limits LL	80% Confidence Limits UL	Standard Deviation	Percent SE of Mean	Coefficient of Variation	$\bar{d}$	H
26 June 1975									
1	22	undefined	undefined	undefined	undefined	undefined	undefined	2.80	2.75
2	28	1,264.5	832.0	1,697.0	198.7	11.1	15.7	2.75	2.72
3	28	1,032.0	567.6	1,496.4	426.5	23.9	41.3	2.78	2.75
4	29	1,044.0	758.1	1,329.9	349.1	16.7	33.4	2.82	2.80
23 September 1975									
1	19	undefined	undefined	undefined	undefined	undefined	undefined	2.75	2.62
2	24	538.5	-63.2	1,140.2	276.5	36.3	51.3	2.87	2.81
3	27	1,033.67	75.8	1,991.5	879.6	49.1	85.1	2.96	2.93

*Step 1 consists of only one sample; Step 2 is the results from 2 pooled samples; Step 3 is the results from 3 pooled samples, etc.

Table 14. Summary of macroinvertebrate community analysis for Birch Creek on 26 June 1975 and 23 September 1975.

Sampling Site	Number of Taxa	Total $\bar{X}$ Number/m^2	% Ephemeroptera	% Plecoptera	% Trichoptera	% Coleoptera	% Diptera	% Other Invertebrates	$\bar{d}$	H
S-1										
26 June 1975	22	16,398	8	1	4	43	41	4	2.41	2.37
23 September 1975	21	13,579	15	3	5	68	7	2	1.88	1.84
S-2										
26 June 1975	29	11,277	9	1	3	37	41	9	2.82	2.80
23 September 1975	27	11,147	37	2	9	30	12	9	2.96	2.93
S-3										
26 June 1975	30	23,521	10	2	3	23	43	19	2.90	2.86
23 September 1975	25	19,131	11	4	6	29	40	10	2.72	2.68
S-4										
26 June 1975	28	7,726	16	4	7	21	30	22	3.38	3.28
23 September 1975	28	9,738	53	11	3	11	14	8	3.26	3.18

Table 15. Number per meter square of macroinvertebrate taxa collected from Birch Creek.

Taxa	26 June 1975				23 September 1975			
	S-1	S-2	S-3	S-4	S-1	S-2	S-3	S-4
Phylum Aschelminthes								
Class Nematoda	32	247	1,679	86	0	183	75	22
Phylum Mollusca								
Class Pelecypoda	0	0	0	0	0	11	22	0
Phylum Annelida								
Class Oligochaeta	291	592	1,786	560	161	430	1,248	291
Phylum Arthropoda								
Class Arachnida								
Order Acarina								
Suborder Hydracarina	334	420	2,625	1,108	172	624	689	517
Class Crustacea								
Order Ostracoda	0	0	0	0	0	0	0	11
Order Copepoda	0	0	22	32	0	0	0	11
Order Cladocera								
Family Daphnidae								
Daphnia sp.	0	22	0	0	0	0	0	0
Class Insecta								
Order Collembola	11	0	0	11	0	0	0	0
Order Ephemeroptera								
Family Siphlonuridae								
Ameletus sp.	0	0	11	0	0	22	0	11
Family Baetidae								
Baetis spp.	1,033	506	1,528	430	1,636	3,153	1,410	2,787
Family Heptageniidae								
Cinygmula sp.	0	32	172	183	118	721	549	1,636
Rhithrogena sp.	0	22	11	0	0	0	22	11
Epeorus sp.	151	97	377	441	0	0	0	334
Family Leptophlebiidae								
Paraleptophlebia sp.	11	215	22	75	194	238	43	75
Family Ephemerellidae								
Ephemerella sp.	97	139	237	54	0	0	0	0
Ephemerella inermis	0	0	11	11	0	0	86	258
Ephemerella doddsi	0	0	22	43	0	0	0	65
Ephemerella grandis	11	0	11	0	22	22	11	11
Family Tricorythidae								
Tricorythodes sp.	0	0	0	0	75	0	0	0
Order Plecoptera								
Family Nemouridae								
Amphinemura mogollonica	0	0	0	0	0	0	A	A
Zapada sp.	0	43	86	0	0	43	43	183
Family Capniidae	0	0	0	0	334	118	667	796
Family Leuctridae	0	0	0	0	0	0	0	11
Family Pteronarcidae								
Pteronarcella badia	86	32(A)	65(A)	11	32	0	0	0
Family Perlodidae								
Isoperla spp.	0	0	0	11	0	0	0	0
Other Perlodidae	0	0	22	0	0	0	0	0
Family Chloroperlidae								
Suwallia pallidula	0	A	0	0	0	0	0	0
Sweltsa lamba	0	A	A	0	0	0	0	0
Triznaka pintada	0	0	A	0	0	0	0	0
Other Chloroperlidae	0	0	183	151	32	11	0	43

Table 15. (continued)

Taxa	26 June 1975 S-1	S-2	S-3	S-4	23 September 1975 S-1	S-2	S-3	S-4
Family Perlidae								
Hesperoperla pacifica	11	22	54	75	0	54	75	75
Other Plecoptera	86	32	54	43	0	0	0	0
Order Hemiptera								
Family Nabidae	0	0	0	0	11	0	0	0
Order Trichoptera								
Family Rhyacophilidae								
Rhyacophila sp.	0	0	97	118	0	0	0	22
Family Glossosomatidae								
Agapetus sp.	0	11	11	0	0	22	108	0
Family Hydropsychidae								
Hydropsyche sp.	463	22	581	355	581	796	861	183
Arctopsyche sp.	0	0	0	11	0	32	22	11
Other Hydropsychidae	65	0	0	0	0	0	0	0
Family Limnephilidae	0	0	32	0	43	140	54	22
Family Lepidostomatidae	0	32	0	32	0	0	0	0
Family Brachycentridae								
Brachycentrus sp.	11	0	11	0	0	0	0	0
Micrasema sp.	0	0	0	0	0	75	65	22
Other Trichoptera	75	43	0	0	0	0	0	0
Order Hymenoptera								
Suborder Chalcidoidea	0	0	0	0	0	11	22	0
Order Coleoptera								
Family Elmidae	6,973	4,121	3,515	1,646	9,168	3,293	5,584	1,033
Optioservus quadrimaculatus								
Narpus sp.								
Family Dryopidae	0	0	0	0	11	11	0	0
Family Dytiscidae	22	11	0	0	0	0	0	0
Family Gyrinidae	0	0	0	11	0	0	0	0
Order Diptera								
Family Tipulidae								
Antocha monticola	32	97	409	43	11	118	506	22
Dicranota sp.	0	22	0	0	32	32	65	11
Hexatoma sp.	0	11	0	0	0	11	0	0
Other Tipulidae	0	11	0	11	0	22	11	0
Family Psychodidae	32	32	97	43	75	11	0	22
Family Dixidae								
Dixa sp.	0	0	0	0	43	32	11	0
Family Simuliidae	3,809	2,163	624	291	11	22	11	32
Simulium sp.								
Family Chironomidae	2,776	2,163	8,640	1,872	786	1,076	6,919	1,237
Family Ceratopogonidae	22	129	258	75	43	22	54	22
Family Empididae	11	22	140	11	0	0	22	0
Family Ephydridae	0	11	0	11	0	0	0	0
Family Muscidae								
Limnophora sp.	0	11	0	0	0	0	0	0

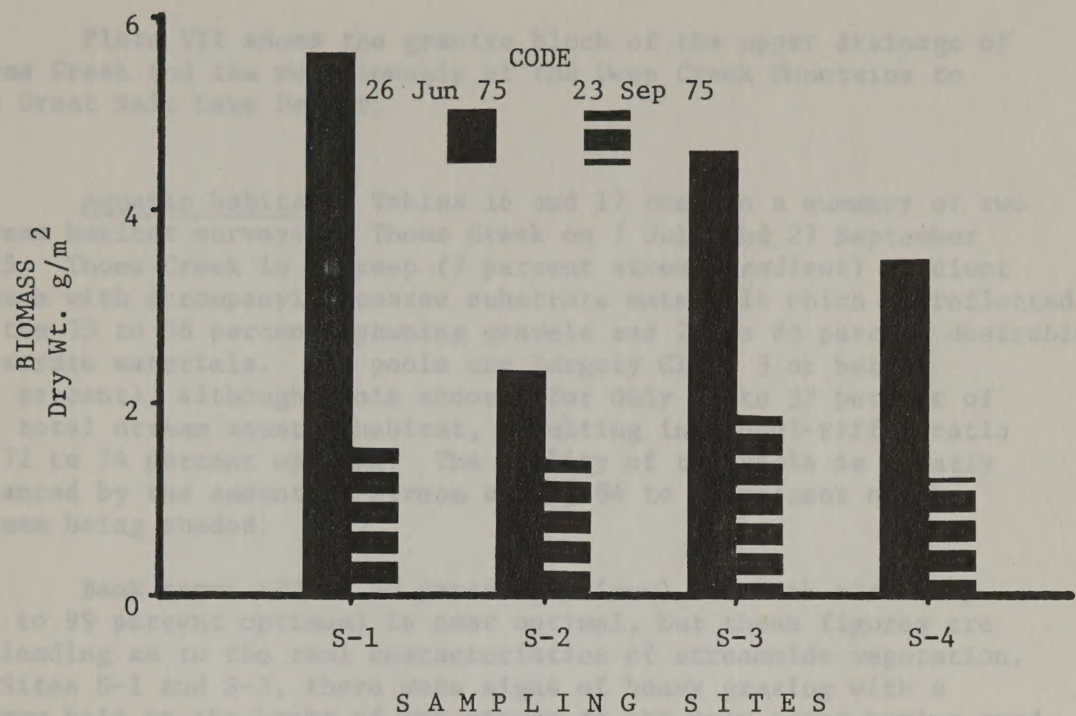


Figure 8. Comparison of macroinvertebrate standing crop (biomass) at four sites on Birch Creek on 26 June 1975 and 23 September 1975.

Thoms Creek

Plate VII shows the granite block of the upper drainage of Thoms Creek and the relationship of the Deep Creek Mountains to the Great Salt Lake Desert.

Aquatic habitat. Tables 16 and 17 contain a summary of two stream habitat surveys of Thoms Creek on 1 July and 27 September 1975. Thoms Creek is a steep (7 percent stream gradient) gradient stream with accompanying coarse substrate materials which is reflected in the 33 to 56 percent spawning gravels and 70 to 83 percent desirable substrate materials. The pools are largely Class 3 or better (67 percent), although pools account for only 36 to 37 percent of the total stream aquatic habitat, resulting in a pool-riffle ratio of 72 to 74 percent optimum. The quality of the pools is greatly enhanced by the amount of stream shade, 84 to 85 percent of the stream being shaded.

Bank cover (87 to 90 percent optimum) and bank stability (88 to 99 percent optimum) is near optimal, but these figures are misleading as to the real characteristics of streamside vegetation. At Sites S-1 and S-3, there were signs of heavy grazing with a narrow belt on the banks of the stream as the only areas having good cover. Even on the banks, all the grass and young tender brush was gone between the trees and brush. The stream banks were stable mainly because of dead brush, logs, and rocks along the edge of the stream channel, and only a small portion of stability was because of live vegetation.

At the present, Thoms Creek is fairly stable with good cover, but under present use the areas surveyed will continually decrease in quality of aquatic habitat. Plates VII to IX show aquatic habitat of Thoms Creek at the time of this survey.

Water quality. Thoms Creek, as suspected of a stream running through granitic substrates, is a soft-water, low alkalinity, clear cold-water mountain stream (Table 18). With the steep stream gradient and coarse substrate materials, the water flow is turbulent, keeping the concentration of dissolved oxygen near saturation. All parameters measured fall within Utah's Class C standards for a cold-water fishery stream.

Nutrient levels are low but not limiting to a fair algal growth. Nitrate and phosphate levels are seasonal with yearly high levels during spring and early summer, associated with leaching from leaves and other organic materials decomposed during winter snow cover.

PLATE VII

PICTURE 1. THOMS CREEK DRAINAGE SHOWING GRANITE STOCK AS EVIDENCED BY HAYSTACK PEAK TO THE SOUTH.

PICTURE 2. DESERT FLOOR LOOKING EAST FROM THE DEEP CREEK MOUNTAINS ACROSS SNAKE VALLEY TOWARD THE FISH SPRINGS RANGE ON SEPTEMBER 27, 1975.

PICTURE 3. THOMS CREEK SHOWING GRANITIC SUBSTRATE AT SITE S-2 ON SEPTEMBER 27, 1975.

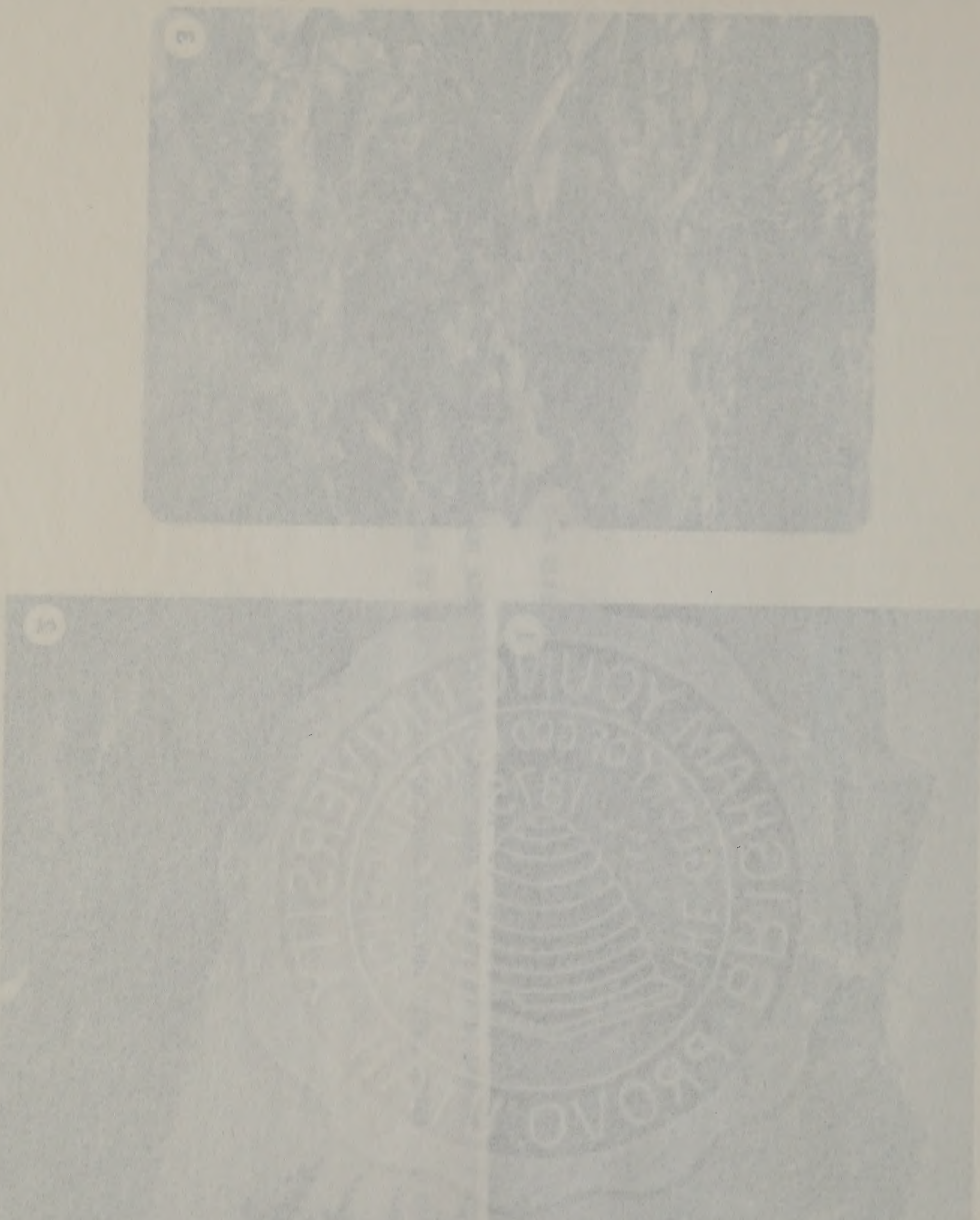


PLATE VIII

PICTURE 1. THOMS CREEK AT SITE S-1, TRANSECT 1 SHOWING DENSE FOREST GROWTH AND STREAM COVER ON JULY 1, 1975.

PICTURE 2. THOMS CREEK SHOWING HEAVILY WOODED NATURE OF SITE S-1 ON JULY 1, 1975.

PICTURE 3. THOMS CREEK AT S-3 SHOWING ABUNDANT DEADFALL ON SEPTEMBER 27, 1975.

PICTURE 4. THOMS CREEK AT S-2 SHOWING CLASS 1 POOL ON SEPTEMBER 27, 1975.


1


2


3


4

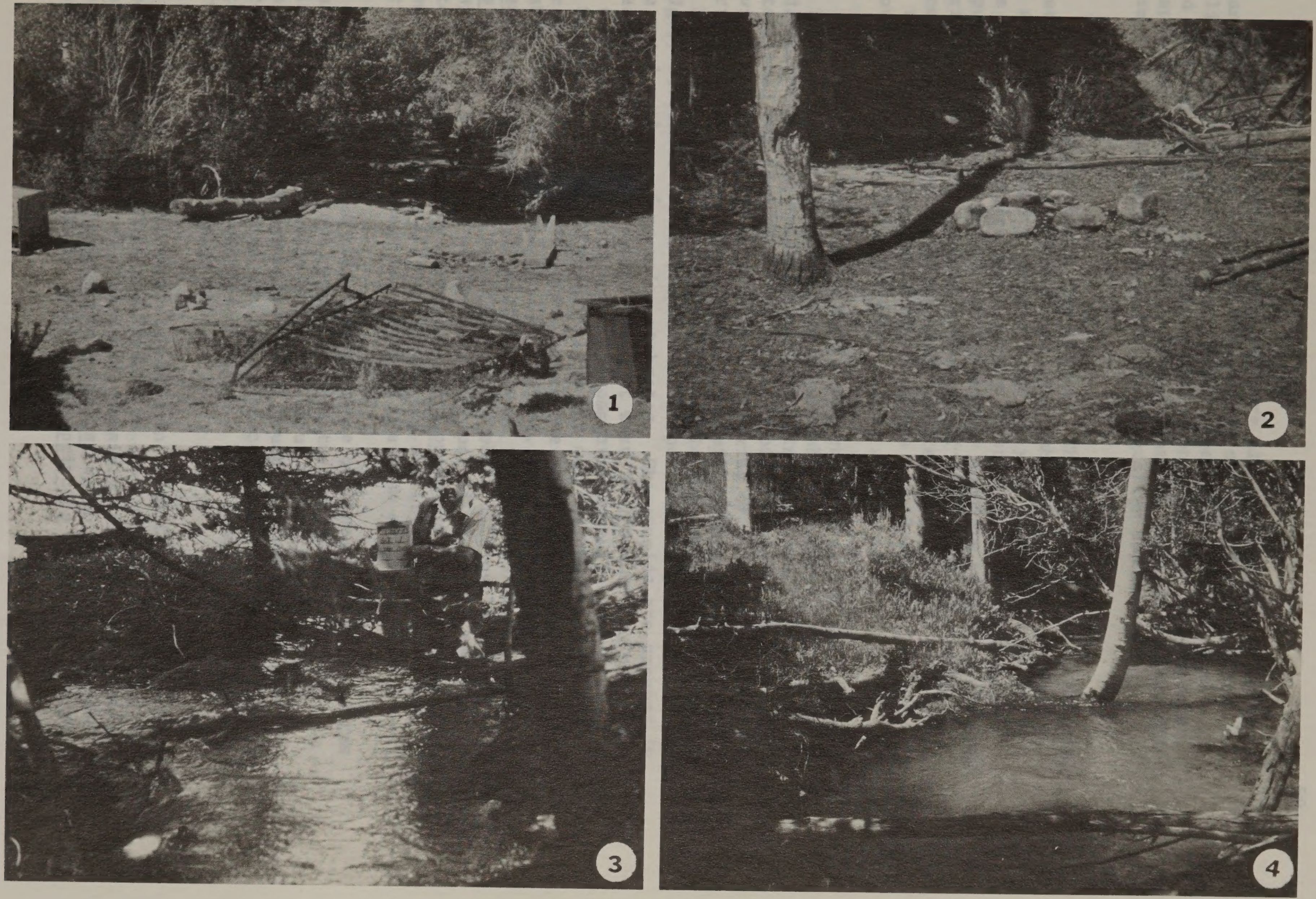
PLATE IX

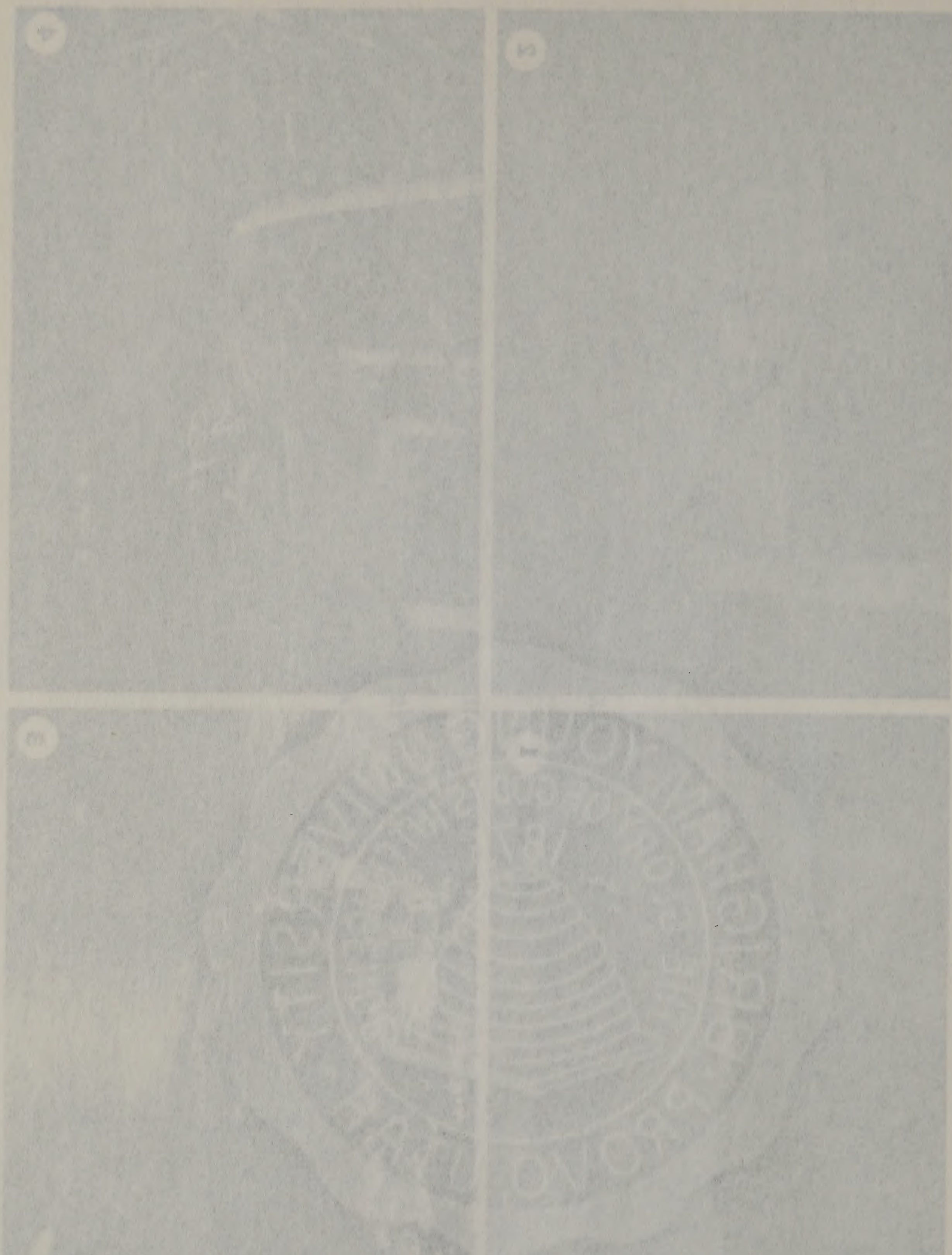
PICTURE 1. THOMS CREEK AT S-3 NEAR FIRST CABIN ON SEPTEMBER 27, 1975 SHOWING GRAZING AND RECREATION IMPACT.

PICTURE 2. THOMS CREEK AT S-3 NEAR FIRST CABIN SHOWING RECREATIONAL AND GRAZING IMPACT NEAR STREAM ON SEPTEMBER 27, 1975.

PICTURE 3. THOMS CREEK SHOWING GOOD SHADE AND COVER AT S-3 ON JULY 1, 1975.

PICTURE 4. THOMS CREEK AT S-3 SHOWING BANK STABILITY AND COVER ON JULY 1, 1975.





Bacteria levels (Table 18) were all considerably below the standards for Class C waters with a high of 210 total and fecal coliform per 100 mls at S-1 on 27 September 1975 and 138 total and 23 fecal coliform per 100 ml at S-3 on 1 July and 27 September, respectively. Cattle probably account for the majority of the coliform bacteria in Thoms Creek during the grazing season.

Macroinvertebrate communities. Thoms Creek is an interesting system in relation to biotic quality. Table 19 presents a summary of sampling reliability using a step analysis of pooled samples. The aquatic communities are slightly clustered, but estimates of population characteristics are relatively accurate with only moderate variance. Table 20 presents a summary of sampling data showing Thoms Creek to have a diverse macroinvertebrate community with from 26 to 36 taxa per site and $\bar{d}$ and H values from 2.21 to 3.75, all above any critically low value.

There are several signs of concern shown in the analyses of Table 19. The high diversity is probably the result of good, undisturbed habitat in past years, allowing many species to become established and adapted to the varied habitat niches. With increasing environmental pressures, such as overgrazing of streamside vegetation, certain indicator species are showing their responses. For example, at Sites S-1 and S-3 on 1 July 1975, dipterans (mainly chironomid midges) accounted for 67 percent and 63 percent, respectively, of the total numbers of macroinvertebrates. Chironomids are present in clean-water, diverse communities; but when they become dominant, it is usually in response to some environmental perturbation. On 27 September 1975 at Site S-1, there was not any dominance by any one taxa, but chironomids and oligochaete worms were still abundant (Table 21). At Site S-3 on 27 September, *Baetis* spp. (mayflies) and *Taenionema nigripennis* (stoneflies) were the two most dominant forms. *Baetis* spp. are a type of mayfly with a short life cycle and quick response to environmental stress, being one of the first forms to enter an area following a stress. *Taenionema nigripennis* is a stonefly with a short life cycle and the ability to survive harsh periods in the egg stage in a form of diapause or inactivity.

It is possible that the dominance of these specialized forms could be the signal to a degenerative situation in Thoms Creek. This is purely supposition but not without supportive evidences. The presence of large amounts of dead brush and trees along the stream tell of past times with dense streamside vegetation, probably with associated plush growths of grass. Now there is extensive bare soil and dead vegetation.

Many of the macroinvertebrates in Thoms Creek are detrial feeders or leaf shredders and feeders on leaf particles produced by the shredders. Among the shredders, possibly the most significant one is the stonefly, *Pteronarcys princeps*, which is rare throughout most of the state of Utah. *Pteronarcys princeps* is common, though,

in the Sierra Nevada Mountains, which are similar in geological formation to the Deep Creek Range. This species may provide the clue to the real relationships of the Deep Creek Mountain cutthroat trout to other isolated strains such as the ones in the Sierra Nevada Mountains. The detrital feeders rely almost entirely for their food on terrestrial leaves entering the stream during the fall. With the demise of streamside deciduous vegetation will come the demise of these forms of stream invertebrates in Thoms Creek.

It is evident that future study is needed of Thoms Creek to determine if a trend is really developing and if so, corrective management measures should be taken. At present there is a high quality diverse macroinvertebrate community in Thoms Creek and correct management efforts should produce excellent results. Macroinvertebrate community evaluations should be continued.

Biomass (Figure 9) of the macroinvertebrate community of Thoms Creek is low; but this is not uncommon in soft-water, high mountain streams. The invertebrates in this stream are generally small, but their high numbers help guarantee exposure of adequate biomass to feeding fishes in the stream.

Management alternatives. Thoms Creek is still a high quality, fairly unique aquatic system, at least for Utah. There are signs of a downward trend in water quality as a result of heavy domestic grazing.

Water flows are small and any diversions of water above the canyon mouth should be prevented. The minimum summer and winter flows are apparently adequate to maintain a diverse aquatic community, but lower flows could result in temperature, dissolved oxygen, and/or habitat availability stresses causing a reduction in the diversity and density of the existing community.

Nutrient levels were not high enough on either sampling date to cause alarm so animal wastes are probably not the main threat to the stream; but loss of dense streamside vegetation from overgrazing could have drastic effects. Removal of streamside vegetation can cause extreme water temperature increases from uncontrolled solar radiation and allow severe bank erosion and stream channel siltation.

The most logical management alternative would be to limit domestic animal access to the stream to selected short stream sections. The major part of the stream should be fenced to provide a buffer zone on both sides of the stream, the width dependent upon bank stability. This would allow growths of dense vegetation which would provide bank stability, stream cover, and shade and habitat for many species of wildlife. Grazing would still be allowed on the watershed, but animal-days should be controlled. This would be the optimal management alternative for multiple-use of this valuable resource.

The two extremes in alternatives would be to either write Thoms Creek off and allow unlimited grazing or to completely remove domestic animals from the area adjoining the stream. Neither of these alternatives is practical or desirable. The actual management may have to be a compromise between one of the extreme alternatives and the optimal; but as far as possible, streamside vegetation should be protected. Aerial infrared photography should aid in determining the width of riparian zones to be protected and the extent of future changes in such.

Table 16. Stream habitat survey summary and analysis for Thoms Creek on 1 July 1975.

1. State, County Utah, Juab	2. District Salt Lake	3. Resource Area--P.U. House Range--Fish Springs
4. Drainage Thoms Creek	5. Stream Unit Thoms Creek	6. Location T. 11S R. 18W Sect. 16-17
7. Investigators Winget, Heckmann, and Reichert		8. Date July 1, 1975

General Data

9.	Total length of stream (mi.)	≈25
10.	Total length of stream surveyed (mi.)	
	a. BLM	2
	b. Public	--
	c. Private	--
11.	Total No. sample stations:	
	a. BLM	3
	b. Public	--
	c. Private	--
12.	Total of all stream width measurements (ft.)	114
13.	Total channel width (ft.)	203
14.	Total width--all pools (ft.)	42
15.	Total width of all pools classed 1, 2, and 3 (ft.)	38
16.	Total footage of desirable bottom materials (ft.)	95
17.	Total spawning gravels (ft.)	65
18.	Sum of cover ratings	86
19.	Sum of stability ratings	95
20.	Elevation: (MSL)	
	a. Lowest	7,400
	b. Highest	8,800
21.	Multiple use zones	remote recreation range use
22.	Number of camera points	≈9
23.	Total cost	
	a. Planning	
	b. Salaries	
	c. Equipment	
	d. Analysis of data	
24.	Cost per station	

Priority A Limiting Factors

25.	Percent of total stream width in pools	37%
26.	Pool-riffle ratio, % optimum	74
27.	Pool quality, % optimum	67
28.	Percent of stream bottom with desirable materials	83
29.	Percent spawning gravels	56
30.	Bank cover, % optimum	90
31.	Bank stability, % optimum	99
32.	Percent of habitat optimum	83

Priority B Limiting Factors

33.	Average depth of stream (ft.)	0.8
34.	Average width of stream (ft.)	9.5
35.	Average width of channel (ft.)	16.9
36.	Percent of bottom with clinging vegetation (ft.)	≈1
37.	Percent of bottom with rooted vegetation (ft.)	--
38.	Percent stream shade	84%
39.	Average stream gradient (%)	7
40.	Average stream velocity (f/s)	2.0
41.	Stream discharge (cfs)	9.4
42.	Average water temperature: (°F or °C)	8° C
43.	Average Air Temperature (°F or °C)	19° C
44.	Turbidity description (clear)	0 JTU
45.	Access (mi.):	
	a. Remote	
	b. Low standard trails	1
	c. Improved trails	
	d. Low standard roads	10
	e. Improved roads	
46.	Water quality analysis:	
	a. Hach kit (pH, Turb. CO_2, DO)	
	b. Chemical (BYU) (Merritt)	X
	c. Coli (Bionics)	X

Table 17. Stream habitat survey summary and analysis for Thoms Creek on 27 September 1975.

1. State, County Utah, Juab	2. District Salt Lake	3. Resource Area--P.U.
4. Drainage Thoms Creek	5. Stream Unit Thoms Creek	6. Location T. 11S R. 18W Sect. 16-17
7. Investigators Winget, Heckmann, and Reichert		8. Date 27 September 1975

General Data

9. Total length of stream (mi.)	≈25
10. Total length of stream surveyed (mi.)	
a. BLM	2
b. Public	--
c. Private	--
11. Total No. sample stations:	
a. BLM	3
b. Public	--
c. Private	--
12. Total of all stream width measurements (ft.)	110
13. Total channel width (ft.)	169
14. Total width--all pools (ft.)	40
15. Total width of all pools classed 1, 2, and 3 (ft.)	37
16. Total footage of desirable bottom materials (ft.)	77
17. Total spawning gravels (ft.)	36
18. Sum of cover ratings	105
19. Sum of stability ratings	106
20. Elevation: (MSL)	
a. Lowest	7,400
b. Highest	8,800
21. Multiple use zones	remote recreation range use
22. Number of camera points	≈9
23. Total cost	
a. Planning	
b. Salaries	
c. Equipment	
d. Analysis of data	
24. Cost per station	

Priority A Limiting Factors

25. Percent of total stream width in pools	36%
26. Pool-riffle ratio, % optimum	72
27. Pool quality, % optimum	67
28. Percent of stream bottom with desirable materials	70
29. Percent spawning gravels	33
30. Bank cover, % optimum	87.5
31. Bank stability, % optimum	88
32. Percent of habitat optimum	77

Priority B Limiting Factors

33. Average depth of stream (ft.)	0.22
34. Average width of stream (ft.)	7.3
35. Average width of channel (ft.)	11.3
36. Percent of bottom with clinging vegetation (ft.)	<1%
37. Percent of bottom with rooted vegetation (ft.)	<1
38. Percent stream shade	85
39. Average stream gradient (%)	6.9
40. Average stream velocity (f/s)	1.45
41. Stream discharge (cfs) (at S-3)	1.28
42. Average water temperature: (°F or °C)	8° C
43. Average Air Temperature (°F or °C)	24° C
44. Turbidity description (clear)	0 JTU
45. Access (mi.):	
a. Remote	
b. Low standard trails	1
c. Improved trails	
d. Low standard roads	10
e. Improved roads	
46. Water quality analysis:	
a. Hach kit	
b. Chemical (BYU)	X
c. Coli (BYU)	X

Table 18. Water quality analysis of Thoms Creek.

Analysis* by	Test	1 July 1975 S-1	1 July 1975 S-3	27 September 1975 S-1	27 September 1975 S-3
	Time	1030	1530	1050	1310
1	Alkalinity, total as $CaCO_3$, mg/l	29	19	18	31
1, 6	Bicarbonate as HCO_3^-, mg/l	35	23	21	38
1	Boron as B, µg/l	--	--	1,150	1,700
1	Calcium as Ca, mg/l	6	5	5	11
1	Carbonate as CO_3, mg/l	<0.1	<0.1	<0.1	<0.1
1	Chloride as Cl, mg/l	1	1	1	1
1	Conductivity, µmhos/cm (25° C)	46.3	54.6	57.6	93.3
1	Hardness as $CaCO_3$, mg/l	34	42	17	33
1	Hydroxide as OH, mg/l	<0.1	<0.1	<0.1	<0.1
1	Magnesium as Mg, mg/l	5	7	1	1
1	pH	7.7	7.6	6.8	8
1	Potassium as K, mg/l	0.5	0.5	0.4	0.5
1	Sodium as Na, mg/l	2.6	3.3	3.3	4
1	Sulfate as SO_4, mg/l	6	6	1	1
1	Total Dissolved Solids	44	52	43	72
3	Turbidity, JTU's	0	0	0	0
3	Dissolved Oxygen as O_2, mg/l	8	--	9	--
1	Nitrate as N, mg/l	0.27	0.49	0.03	0.04
1	Phosphate (Total) as P, mg/l	0.008	0.017	--	--
1	Phosphate (ortho) as P, mg/l	<0.001	0.017	0.008	0.004
3	Air Temperature, °C	18	20	19	26
3	Water Temperature, °C	6	9	6	9
4, 1	Total Coliform, MPN/100 ml	86	138	210	210
4, 1	Fecal Coliform, MPN/100 ml	2	8	210	23

*1. BYU Environmental Analysis Laboratories
2. USGS
3. Field determinations
4. Bionics
5. Utah Department of Health and Welfare
6. Ford Laboratory, Salt Lake City

Table 19. Statistics for stepwise pooled samples for Thoms Creek Site S-3 on 1 July 1975 and 27 September 1975.

Step*	Total No. of Taxa	Mean No/ft^2	80% Confidence Limits LL	80% Confidence Limits UL	Standard Deviation	Percent SE of Mean	Coefficient of Variation	$\bar{d}$	H
1 July 1975									
1	18	undefined	undefined	undefined	undefined	undefined	undefined	2.34	2.22
2	25	341.5	198.4	484.6	65.8	13.6	19.3	2.38	2.28
3	29	480.0	213.9	746.1	244.4	29.4	50.9	2.59	2.53
27 September 1975									
1	26	undefined	undefined	undefined	undefined	undefined	undefined	3.31	3.28
2	30	3,798.0	1,489.5	6,106.5	1,060.7	19.8	27.9	3.44	3.41
3	33	3,561.3	2,630.6	4,492.0	854.7	13.9	24.0	3.37	3.34

*Step 1 consists of only one sample; Step 2 is the results from 2 pooled samples; Step 3 is the results from 3 pooled samples, etc.

Table 20. Summary of macroinvertebrate community analysis for Thoms Creek on 1 July 1975 and 27 September 1975.

Sampling Site	Number of Taxa	Total $\bar{X}$ number/m^2	% Ephemeroptera	% Plecoptera	% Trichoptera	% Coleoptera	% Diptera	% Other Invertebrates	$\bar{d}$	H
S-1										
1 July 1975	29	9,845	11	9	1	0	67	12	2.21	2.14
27 September 1975	28	19,992	21	37	7	0	15	20	3.58	3.53
S-2										
1 July 1975	26	4,272	34	5	3	0	44	14	2.90	2.76
27 September 1975	36	29,924	24	24	7	0.1	30	15	3.75	3.71
S-3										
1 July 1975	26	5,143	21	4	1	0	63	10	2.59	2.53
27 September 1975	33	38,413	40	39	0.4	0	15	5	3.37	3.34

Table 21. Number per meter square of macroinvertebrate taxa collected from Thoms Creek.

Taxa	1 July 1975 S-1	S-2	S-3	27 September 1975 S-1	S-2	S-3
Phylum Platyhelminthes						
Class Turbellaria						
Order Tricladia (Planaria)	86	75	0	968	742	32
Phylum Aschelminthes						
Class Nematoda	129	11	32	0	65	129
Phylum Mollusca						
Class Pelecypoda	11	0	0	0	0	0
Phylum Annelida						
Class Oligochaeta	549	258	183	1,528	301	689
Phylum Arthropoda						
Class Arachnida						
Order Acarina						
Suborder Hydracarina	409	269	301	1,420	3,271	1,173
Class Crustacea						
Order Ostracoda	86	0	22	344	893	291
Order Copepoda	22	0	140	0	183	118
Class Insecta						
Order Collembola	0	11	0	0	0	0
Family Entomobryidae	0	0	11	161	732	0
Family Smynthuridae	0	0	32	0	0	0
Order Ephemeroptera						
Family Siphlonuridae						
Ameletus sp.	32	0	0	11	54	21
Family Baetidae						
Baetis spp.	581	909	420	925	4,562	7,607
Family Heptageniidae	0	0	0	0	75	0
Cinygmula sp.	301	291	161	2,550	1,022	1,614
Epeorus sp.	21	108	183	0	0	0
Epeorus deceptivus	0	0	0	22	11	11
Epeorus longimanus	0	0	0	54	118	1,108
Family Leptophlebiidae						
Paraleptophlebia sp.	43	43	118	182	850	3,508
Family Ephemerellidae						
Ephemerella spp.	11	0	118	161	204	495
Ephemerella doddsi	0	0	54	387	355	1,098
Ephemerella coloradensis	11	11	32	0	0	0
Other Ephemeroptera	65	11	11	0	0	0

Table 21. (continued).

Taxa	1 July 1975 S-1	S-2	S-3	27 September 1975 S-1	S-2	S-3
Order Plecoptera						
Family Nemouridae						
Malenka californica	0	0	0	A	0	0
Zapada sp.	140	32	75	65	1,668	581
Zapada cintipes	0	0	0	0	0	11
Other Nemouridae	0	0	0	0	1,334	0
Family Capniidae	603	86	54	3,013	2,421	4,110
Family Taeniopterygidae						
Taenionema nigripennis	0	A	0	11	22	9,781
Family Leuctridae	0	0	0	2,087	1,011	0
Family Pteronarcidae						
Pteronarcys princeps	0	0	0	0	0	54
Family Perlodidae						
Megarcys signata	0	0	0	22	32	0
Other Perlodidae	86	65	0	0	0	0
Family Chloroperlidae						
Paraperla frontalis	0	11	0	0	0	0
Other Chloroperlidae	11	0	22	108	86	204
Family Perlidae						
Hesperoperla pacifica	0	0	0	0	0	97
Other Plecoptera	22	0	32	2,055	656	0
Order Trichoptera						
Family Rhyacophilidae						
Rhyacophila sp.	108	108	22	1,356	1,162	54
Family Glossosomatidae						
Agapetus sp.	33	11	22	75	108	65
Family Philopotamidae	0	0	0	0	172	11
Family Limnephilidae						
Oligophlebodes sp.	0	11	0	0	0	0
Other Limnephilidae	0	11	11	22	603	11
Family Brachycentridae						
Brachycentrus sp.	0	0	11	0	0	11
Order Lepidoptera	11	0	0	0	0	0
Order Hymenoptera	0	0	0	11	11	0
Order Coleoptera						
Family Elmidae	0	0	0	0	22	11
Order Diptera						
Family Tipulidae						
Antocha monticola	0	0	0	0	11	0
Dicranota sp.	32	11	11	32	43	75
Hexatoma sp.	0	0	0	0	0	11
Tipulidae sp. A	0	0	0	0	11	11
Other Tipulidae	11	11	22	22	0	0
Family Psychodidae	0	0	0	32	280	1,313
Family Dixidae						
Dixa sp.	21	22	0	11	118	0
Family Simuliidae	21	32	32	54	829	829
Family Chironomidae	6,402	1,710	3,088	2,765	7,413	3,486
Family Ceratopogonidae	21	11	43	0	11	43
Family Empididae	43	32	32	54	247	161
Other Diptera	32	43	54	0	32	0

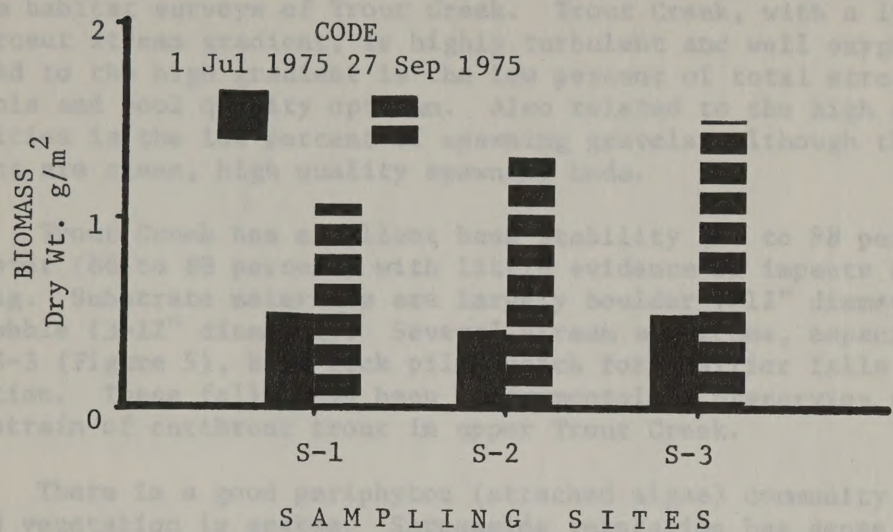


Figure 9. Comparison of macroinvertebrate standing crop (biomass) at three sites on Thoms Creek on 1 July 1975 and 27 September 1975.

Trout Creek

Plates X to XII contain photographs of stream conditions existing during this survey.

Aquatic habitat. Tables 22 and 23 present a summary of two stream habitat surveys of Trout Creek. Trout Creek, with a 10.5 to 11 percent stream gradient, is highly turbulent and well oxygenated. Related to the high gradient is the low percent of total stream width in pools and pool quality optimum. Also related to the high stream velocities is the low percent of spawning gravels, although those present are clean, high quality spawning beds.

Trout Creek has excellent bank stability (84 to 88 percent) and cover (86 to 88 percent) with little evidence of impacts from grazing. Substrate materials are largely boulder (>12" diameter) and rubble (3-12" diameter). Several stream stretches, especially near S-3 (Figure 5), have rock piles which form barrier falls to fish migration. These falls have been instrumental in preserving the pure strain of cutthroat trout in upper Trout Creek.

There is a good periphyton (attached algae) community, but rooted vegetation is sparse. Streamside vegetation has dense growths of river birch, quaken aspen, fir trees, pinyon trees with various small shrubs such as mountain mahogany, wild rose, sage, and rabbit brush.

At present the aquatic habitat is good with little evidence of human-use related impacts. The location of a mining claim (Figure 5) on the headwaters of Trout Creek poses a real threat to future aquatic habitat.

Water quality. Table 24 presents a summary of water quality analyses of Trout Creek waters. In general, Trout Creek is a soft water, bicarbonate buffered, highly oxygenated, cold clear mountain stream.

Nutrients are present in low concentrations but high enough to support good periphyton growths and a diverse aquatic community. Nitrogen is seasonal in its concentrations with highs following spring snow melt and lows in late summer through winter. Phosphate levels appear fairly constant with levels low (0.003 to 0.02 mg/1).

Macroinvertebrate community. Table 26 presents a summary of step analysis of pooled samples from S-3 on Trout Creek. With standard errors of the mean only 14.2 on 2 July and 19.7 on 26 September, it can be assumed that adequate samples were taken and the aquatic communities were only moderately clustered in their distribution.

PLATE X

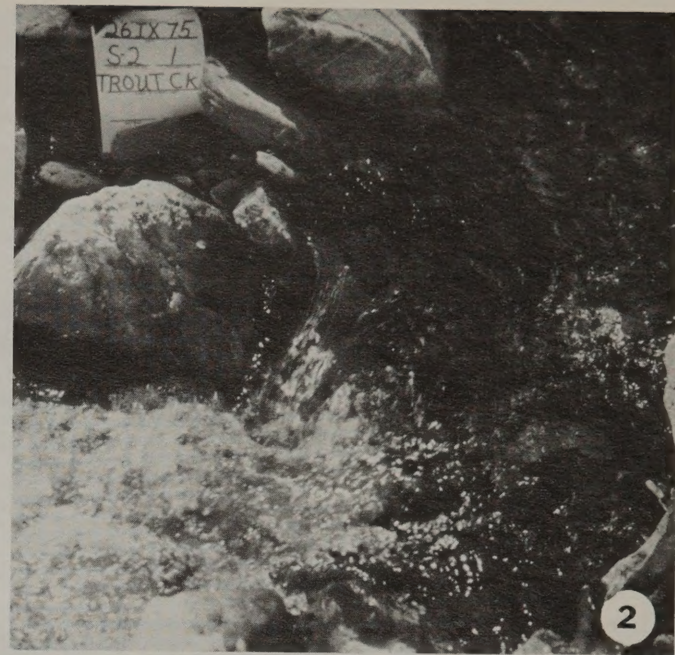
PICTURE 1. TROUT CREEK AT S-2 SHOWING RUBBLE SUBSTRATE ON SEPTEMBER 26, 1975.

PICTURE 2. TROUT CREEK AT S-2, TRANSECT 1, SHOWING SILT-FREE SUBSTRATE.

PICTURE 3. TROUT CREEK AT S-1, TRANSECT 3, SHOWING SUBSTRATE.

PICTURE 4. TROUT CREEK AT S-1, TRANSECT 1, SHOWING BANK STABILITY AND RIPARIAN VEGETATION ON JULY 2, 1975.


1


26 IX 75
S-2 1
TROUT CK
2


3


4

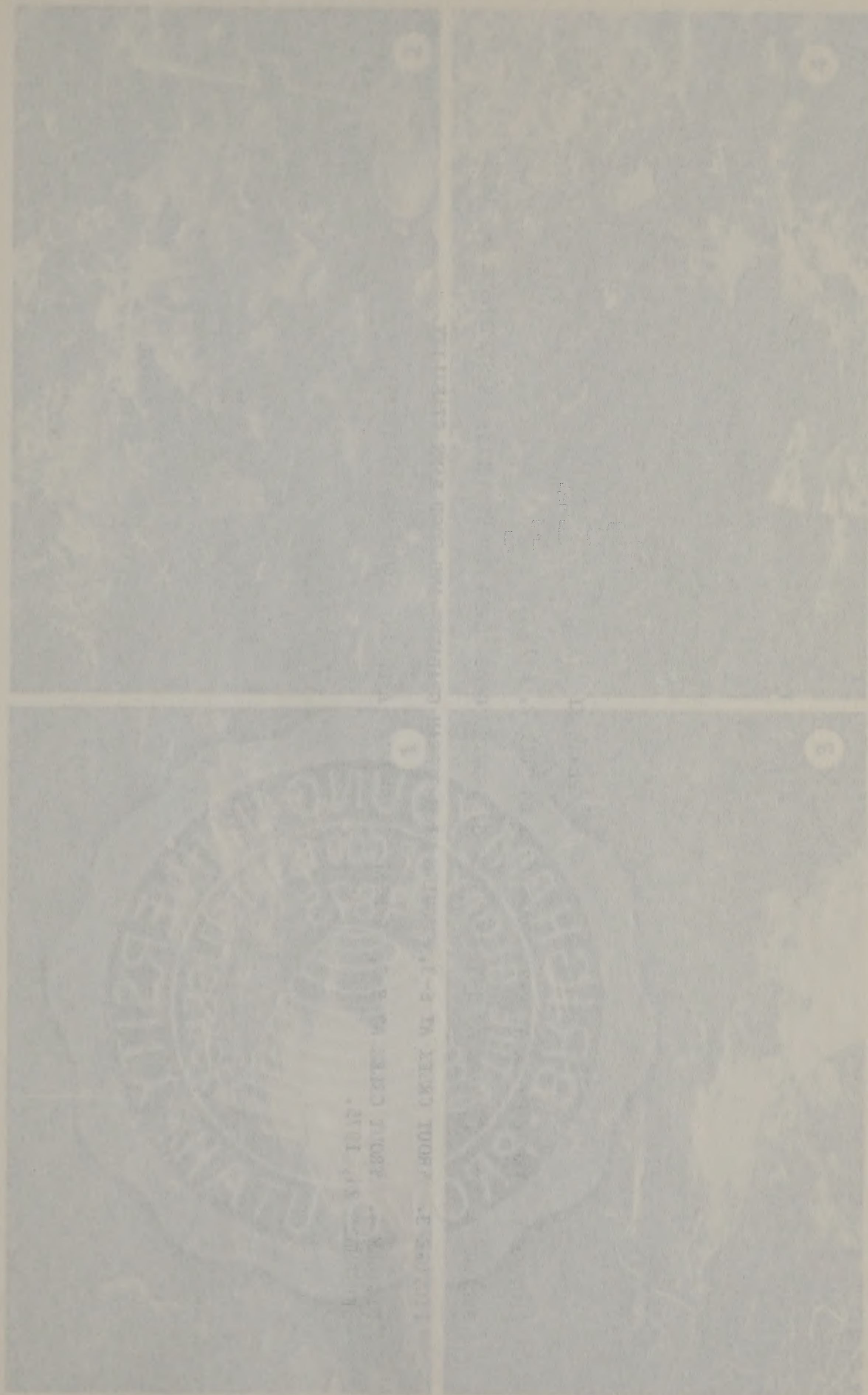


PLATE XI

PICTURE 1. TROUT CREEK AT S-2, TRANSECT 3 ON JULY 2, 1975.

PICTURE 2. TROUT CREEK AT S-3, TRANSECT 5, SHOWING GOOD COVER AND STABILITY ON SEPTEMBER 26, 1975.

PICTURE 3. TROUT CREEK AT S-3, SHOWING HIGH STREAM GRADIENT AND GOOD BANK STABILITY.

PICTURE 4. TROUT CREEK AT S-3, TRANSECT 3, SHOWING ABUNDANT COVER AND STABILITY ON SEPTEMBER 26, 1975.


1


2


3


4

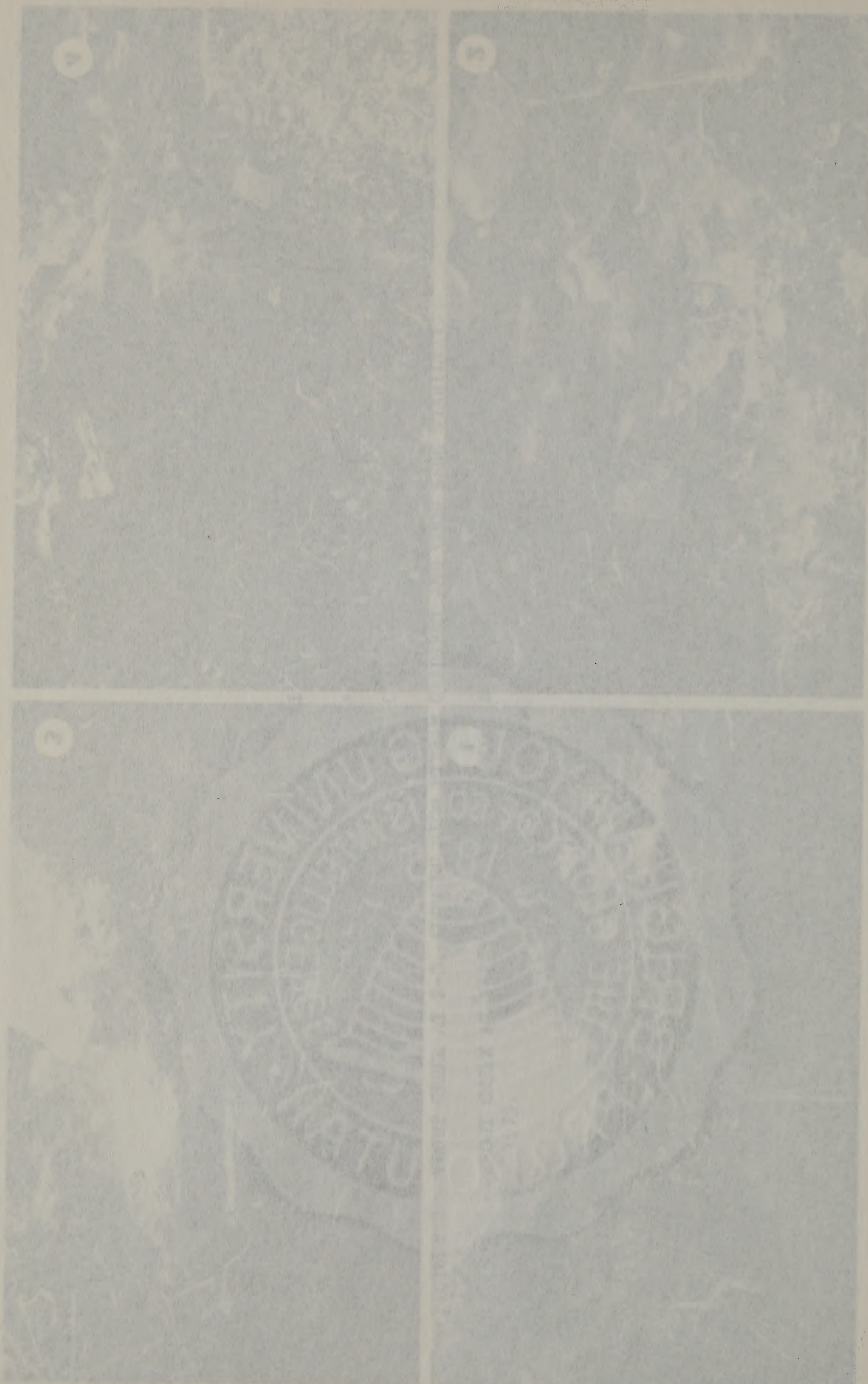


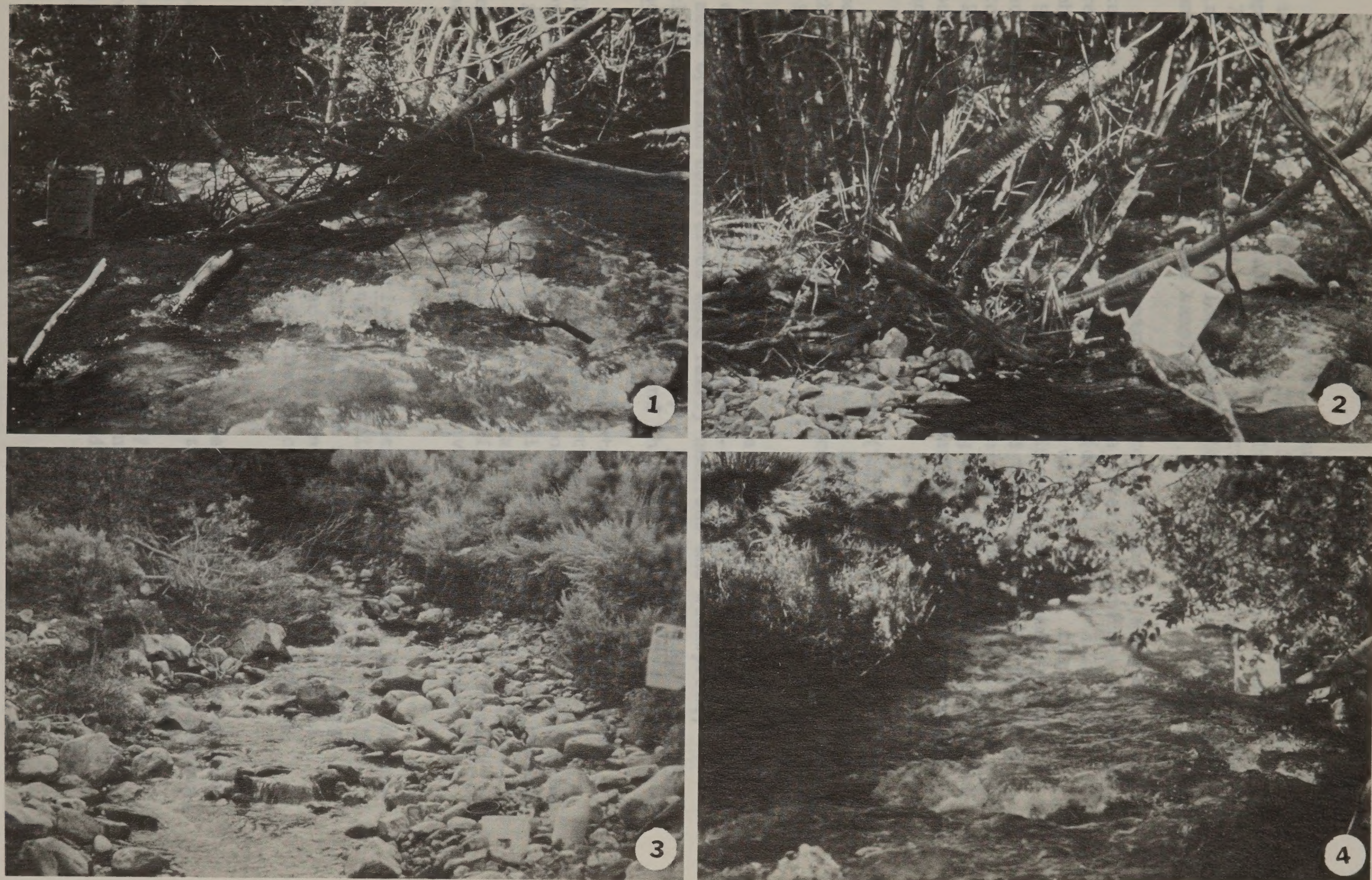
PLATE XII

PICTURE 1. TROUT CREEK DURING HIGH RUNOFF AT S-4, TRANSECT 1, ON JULY 1, 1975.

PICTURE 2. TROUT CREEK AT S-4, TRANSECT 1, ON SEPTEMBER 26, 1975, SHOWING ABUNDANT RIPARIAN VEGETATION.

PICTURE 3. TROUT CREEK AT S-5, TRANSECT 1, NEAR GAUGING STATION, SHOWING DESERT TYPE RIPARIAN VEGETATION.

PICTURE 4. TROUT CREEK AT S-5, TRANSECT 1, ON JULY 2, 1975, SHOWING HIGH RUNOFF.


1
2
3
4

On 2 July 1975 the number of taxa sampled increased from 20 in two samples to 23 in three. This indicates that additional samples would probably have included additional taxa not sampled. On 26 September there was only one additional taxa collected in the third sample, indicating a low probability of collecting many additional taxa by taking more samples.

Table 27 gives a summary of macroinvertebrate samples at all sites on both sampling dates. Dominance diversity indices ($\bar{d}$ and H) were high with a range of 2.70 to 3.41 ($\bar{d}$) and 2.64 to 3.32 (H). Number of taxa was lower on 2 July 1975 with 15 to 23, than on 26 September 1975 with 28 to 33. This is to be expected as many species would have emerged by 2 July and their eggs would not have hatched or young instars would have been too small to identify. By 26 September many young of the spring emergers would have acquired enough summer growth to allow identification to family or perhaps even genus.

Total numbers per meter square (Table 27) were considerably lower on 2 July, perhaps as a result of high spring runoff coupled with spring emergence. Numbers had increased substantially by 26 September.

Table 28 contains a list of taxa collected and their numbers at each site for the two sampling dates. Several species indicative of near optimum conditions were fairly numerous and widespread, including: the mayflies *Cinygmula* sp., *Epeorus deceptivus*, *Epeorus cinctipes*, Capniidae, Leuctridae, and Chloroperlidae.

In general, the macroinvertebrate samples from Trout Creek indicate a healthy, diverse, and productive community capable of supporting a fisheries of native cutthroat trout. Biomass (Figure 10) is good for a soft-water stream but still low enough that care should be taken to preserve the macroinvertebrate diversity and abundance. Communities of macroinvertebrates in soft waters are often fragile communities with marked responses to environmental perturbations.

Management alternatives. Impacts to Trout Creek are probably going to be limited to mining, road building, and grazing. At the present, the greatest concern should be mining and road building. Further increases of man's activities on the fragile environment would cause significant degradation of critical aquatic habitats on the mountain.

It is imperative that Trout Creek be protected from siltation because with the high water velocities there would be severe scouring, the sediments acting as grinding powder on the aquatic organisms. Mine wastes, including overburden, heavy metals, acids, etc. would have the immediate effects of eliminating several taxa and reducing the density of others. Other taxa would show varied responses, depending upon the type and severity of perturbation. In order for

effective energy flow from terrestrial and aquatic plants to invertebrates and finally to the cutthroat trout, a good diverse community of macroinvertebrates needs to be preserved.

Trout Creek is a unique desert-mountain stream with unique aquatic communities and as such should have strict management controls insuring maintenance of quality aquatic habitat. The streamside vegetation is possibly the most important factor in controlling quality stream habitat, thus there should be a buffer zone of several hundred feet undisturbed between any development and Trout Creek.

Because of the primitive and unique characteristics of Trout Creek, there should be only one management choice with no alternatives, and that is to preserve the existing stream quality and conditions. This includes preventing any stream channelization, diversion of waters above the canyon mouth, clearing of streamside vegetation, or any other activity which will cause pollution of the aquatic environment.

Continued evaluation surveys are necessary to provide the baseline for evaluating effectiveness of management procedures and impacts of resource development. Water quality and macroinvertebrate samples should be taken on a regular basis with periodic bacterial analyses. Infrared color aerial photographs would aid in measuring riparian plant community changes--information necessary in determining width of riparian vegetation buffer zones along the stream.

Table 22. Stream habitat survey summary and analysis for Trout Creek on 2 July 1975.

1. State, County Utah, Juab	2. District Salt Lake	3. Resource Area--P.U. House Range--Fish Springs
4. Drainage Trout Creek	5. Stream Unit Trout Creek	6. Location T. 12S R. 18W Sect. 33
7. Investigators Winget, Heckmann, and Reichert		8. Date July 2, 1975

General Data

9.	Total length of stream (mi.)	≈20
10.	Total length of stream surveyed (mi.)	
	a. BLM	4.5
	b. Public	--
	c. Private	--
11.	Total No. sample stations:	
	a. BLM	5
	b. Public	--
	c. Private	--
12.	Total of all stream width measurements (ft.)	309
13.	Total channel width (ft.)	470
14.	Total width--all pools (ft.)	62
15.	Total width of all pools classed 1, 2, and 3 (ft.)	56
16.	Total footage of desirable bottom materials (ft.)	246
17.	Total spawning gravels (ft.)	88
18.	Sum of cover ratings	147
19.	Sum of stability ratings	148
20.	Elevation: (MSL)	
	a. Lowest	6,500
	b. Highest	9,000
21.	Multiple use zones	remote recreation range--mining
22.	Number of camera points	
23.	Total cost	
	a. Planning	
	b. Salaries	
	c. Equipment	
	d. Analysis of data	
24.	Cost per station	

Priority A Limiting Factors

25.	Percent of total stream width in pools	20%
26.	Pool-riffle ratio, % optimum	40
27.	Pool quality, % optimum	36
28.	Percent of stream bottom with desirable materials	80
29.	Percent spawning gravels	28
30.	Bank cover, % optimum	88
31.	Bank stability, % optimum	88
32.	Percent of habitat optimum	66

Priority B Limiting Factors

33.	Average depth of stream (ft.)	0.6
34.	Average width of stream (ft.)	15
35.	Average width of channel (ft.)	22.4
36.	Percent of bottom with clinging vegetation (ft.)	3%
37.	Percent of bottom with rooted vegetation (ft.)	2%
38.	Percent stream shade	82
39.	Average stream gradient (%)	11
40.	Average stream velocity (f/s)	3.0
41.	Stream discharge (cfs) (at S-5 near USGS gauging stn)	33
42.	Average water temperature: (°F or °C)	8° C
43.	Average Air Temperature (°F or °C)	19.5°C
44.	Turbidity description	0 JTU
45.	Access (mi.):	
	a. Remote	
	b. Low standard trails	2
	c. Improved trails	
	d. Low standard roads	2
	e. Improved roads	
46.	Water quality analysis:	
	a. Hach kit (pH, CO_2, DO, Turbidity	
	b. Chemical (BYU)	X
	c. Coli (Bionics)	X

Table 23. Stream habitat survey summary and analysis for Trout Creek on 26 September 1975.

1. State, County Utah, Juab	2. District Salt Lake	3. Resource Area--P.U. House Range--Fish Springs
4. Drainage Trout Creek	5. Stream Unit Trout Creek	6. Location T. 12S R. 18W Sect. 33
7. Investigators Winget, Heckmann, and Reichert		8. Date 26 September 1975

General Data	
9. Total length of stream (mi.)	≈20
10. Total length of stream surveyed (mi.)	
a. BLM	4.5
b. Public	--
c. Private	--
11. Total No. sample stations:	
a. BLM	5
b. Public	--
c. Private	--
12. Total of all stream width measurements (ft.)	282
13. Total channel width (ft.)	487
14. Total width--all pools (ft.)	91
15. Total width of all pools classed 1, 2, and 3 (ft.)	83
16. Total footage of desirable bottom materials (ft.)	146
17. Total spawning gravels (ft.)	54
18. Sum of cover ratings	171
19. Sum of stability ratings	168
20. Elevation: (MSL)	
a. Lowest	6,500
b. Highest	9,000
21. Multiple use zones	remote recreation range and mining
22. Number of camera points	≈15
23. Total cost	
a. Planning	
b. Salaries	
c. Equipment	
d. Analysis of data	
24. Cost per station	

Priority A Limiting Factors	
25. Percent of total stream width in pools	32
26. Pool-riffle ratio, % optimum	64
27. Pool quality, % optimum	58
28. Percent of stream bottom with desirable materials	52
29. Percent spawning gravels	19
30. Bank cover, % optimum	86
31. Bank stability, % optimum	84
32. Percent of habitat optimum	69
Priority B Limiting Factors	
33. Average depth of stream (ft.)	0.34
34. Average width of stream (ft.)	11.3
35. Average width of channel (ft.)	19.5
36. Percent of bottom with clinging vegetation (ft.)	1%
37. Percent of bottom with rooted vegetation (ft.)	<1
38. Percent stream shade	64
39. Average stream gradient (%)	10.5
40. Average stream velocity (f/s)	1.61
41. Stream discharge (cfs) (at Site S-5)	4.54
42. Average water temperature: (°F or °C)	8.6°C
43. Average Air Temperature (°F or °C)	18° C
44. Turbidity description (clear)	0 JTU
45. Access (mi.):	
a. Remote	
b. Low standard trails	2
c. Improved trails	
d. Low standard roads	2
e. Improved roads	
46. Water quality analysis:	
a. Hach kit	
b. Chemical (BYU)	X
c. Coli (BYU)	X

Table 24. Water quality analysis of Trout Creek.

Analysis* by	Test	2 July 1975 S-1	2 July 1975 S-5	26 September 1975 S-1	26 September 1975 S-4	26 September 1975 S-5
	Time	1130	1800	1130	1600	1735
1	Alkalinity, total as $CaCO_3$, mg/l	16	--	12	20	21
1	Bicarbonate as HCO_3^-, mg/l	20	--	14	24	26
6	Boron as B, µg/l	--	--	1,100	1,650	1,660
1	Calcium as Ca, mg/l	5	--	6	8	8
1	Carbonate as CO_3, mg/l	<0.1	--	<0.1	<0.1	<0.1
1	Chloride as Cl, mg/l	2	--	1	2	2
1	Conductivity, µmhos/cm (25° C)	44.1	--	58.8	67.6	74.1
1	Hardness as $CaCO_3$, mg/l	34	--	19	25	28
1	Hydroxide as OH, mg/l	<0.1	--	<0.1	<0.1	<0.1
1	Magnesium as Mg, mg/l	5	--	1	1	2
1	pH	7.6	7.2	6.3	6.8	6.8
1	Potassium as K, mg/l	0.5	--	0.5	0.6	0.7
1	Sodium as Na, mg/l	2.3	--	2.6	2.9	3.4
1	Sulfate as SO_4, mg/l	9.0	--	5	6	8
1	Total Dissolved Solids	42	--	41	46	54
3	Turbidity, JTU's	0	0	0	0	0
3	Dissolved Oxygen as O_2, mg/l	--	9	9	--	--
1	Nitrate as N, mg/l	0.23	--	0.04	0.03	0.03
1	Phosphate (Total) as P, mg/l	0.003	--	--	--	--
1	Phosphate (ortho) as P, mg/l	<0.001	--	0.016	0.009	0.007
3	Air Temperature, °C	19	18	18	19	--
3	Water Temperature, °C	6	10	7.5	10	--
4, 1	Total Coliform, MPN/100 ml	14	--	--	20	43
4, 1	Fecal Coliform, MPN/100 ml	3	--	--	<3	<3

*1. BYU Environmental Analysis Laboratories
2. USGS
3. Field determinations
4. Bionics
5. Utah Department of Health and Welfare
6. Ford Laboratory, Salt Lake City

Table 25. Trout Creek water temperature data--daily minimum and maximum temperatures (°C) for July 4 to August 4, 1975.

Date	Min	Max	Date	Min	Max
July 4	6.5	9.0	July 21	8.5	10.5
5	7.0	9.5	22	8.5	10.5
6	7.5	9.0	23	9.0	10.5
7	7.5	10.0	24	9.5	10.0
8	8.0	10.5	25	9.5	10.5
9	8.5	10.0	26	9.5	11.0
10	8.5	9.5	27	9.5	10.5
11	8.5	9.5	28	10.0	11.0
12	8.0	9.0	29	10.5	11.0
13	8.5	10.0	30	10.0	11.0
14	8.5	10.5	31	9.0	9.5
15	8.5	10.0	Aug. 1	8.5	10.0
16	8.5	9.0	2	9.0	10.5
17	8.0	9.0	3	9.0	10.5
18	8.5	10.0	4	9.0	11.0
19	8.5	10.0			
20	8.0	10.0			
15-day mean	8.9		15-day mean	9.9	

Table 26. Statistics for stepwise pooled samples for Trout Creek Site S-3 on 2 July 1975 and 26 September 1975.

Step*	Total No. of Taxa	Mean No/ft^2	80% Confidence Limits LL	80% Confidence Limits UL	Standard Deviation	Percent SE of Mean	Coefficient of Variation	$\bar{d}$	H
2 July 1975									
1	12	undefined	undefined	undefined	undefined	undefined	undefined	2.48	2.39
2	20	464.5	195.2	733.8	123.7	18.8	26.6	2.71	2.65
3	23	430.3	315.3	545.4	105.6	14.2	24.6	2.70	2.64
26 September 1975									
1	25	undefined	undefined	undefined	undefined	undefined	undefined	2.78	2.76
2	28	3,424.5	588.1	6,260.9	1,303.2	26.9	38.1	2.88	2.86
3	29	3,117.3	1,958.7	4,276.0	1,064.1	19.7	34.1	2.98	2.96

*Step 1 consists of only one sample; Step 2 is the results from 2 pooled samples; Step 3 is the results from 3 pooled samples, etc.

Table 27. Summary of macroinvertebrate community analysis for Trout Creek on 2 July 1975 and 26 September 1975.

Sampling Site	Number of Taxa	Total $\bar{X}$ Number/m^2	% Ephemeroptera	% Plecoptera	% Trichoptera	% Coleoptera	% Diptera	% Other Invertebrates	$\bar{d}$	H
S-1										
2 July 1975	18	4,939	53	14	3	0	20	10	3.00	2.90
26 September 1975	28	18,260	19	47	5	0.5	16	11	3.37	3.32
S-2										
2 July 1975	15	2,744	53	10	5	0	23	9	3.09	2.94
26 September 1975	29	29,482	15	54	3	0.1	20	8	2.97	2.93
S-3										
2 July 1975	23	4,670	45	7	3	0.5	40	5	2.70	2.64
26 September 1975	29	33,611	21	55	2	0.8	12	10	2.98	2.96
S-4										
2 July 1975	20	5,993	38	12	1	1	40	8	2.93	2.83
26 September 1975	28	20,638	42	39	1	2	7	8	3.12	3.08
S-5										
2 July 1975	21	4,401	30	11	3	18	29	9	3.41	3.28
26 September 1975	33	34,819	70	7	1	2	10	9	2.78	2.74

Table 28. Number per meter square of macroinvertebrate taxa collected from Trout Creek.

Taxa	2 July 1975 S-1	S-2	S-3	S-4	S-5	26 September 1975 S-1	S-2	S-3	S-4	S-5
Phylum Platyhelminthes										
Class Turbellaria										
Order Tricladia (Planaria)	0	54	0	0	0	1,001	538	54	43	11
Phylum Aschelminthes										
Class Nematoda	0	0	11	0	0	22	32	32	86	43
Phylum Annelida										
Class Oligochaeta	0	0	11	43	0	54	54	65	32	248
Phylum Arthropoda										
Class Arachnida										
Order Acarina										
Suborder Hydracarina	484	248	226	420	420	2,034	2,399	3,303	1,603	2,765
Class Crustacea										
Order Ostracoda	43	11	11	11	0	32	32	0	43	22
Order Copepoda	0	0	0	0	0	0	11	11	0	0
Class Insecta										
Order Collembola	11	0	0	0	0	0	0	0	0	0
Family Entomobryidae	0	0	0	0	0	86	97	0	0	0
Family Smynthuridae	0	0	11	0	0	0	0	0	0	0
Order Ephemeroptera										
Family Siphlonuridae										
Ameletus sp.	0	0	0	0	0	0	0	11	11	0
Family Baetidae										
Baetis sp.	538	291	161	237	409	1,345	1,172	3,185	6,166	17,657
Family Heptageniidae										
Cinygmula sp.	667	699	560	667	452	710	1,313	1,130	753	2,787
Epeorus sp.	1,334	441	1,270	1,086	280	0	0	0	0	0
Epeorus deceptivus	0	0	0	0	0	301	236	182	75	0
Epeorus longimanus	0	0	0	0	0	538	1,291	1,808	1,269	3,195
Other Heptageniidae	53	0	0	0	0	11	86	291	0	0
Family Leptophlebiidae	0									
Paraleptophlebia sp.	0	0	11	215	97	0	0	54	139	688
Family Ephemerellidae										
Ephemerella sp.	0	0	32	0	75	0	0	43	0	11
Ephemerella doddsi	0	22	32	32	11	613	344	291	334	226
Ephemerella coloradensis	0	0	0	11	0	0	11	0	0	0
Other Ephemeroptera	11	0	32	65	0	0	11	0	0	0
Order Plecoptera										
Family Nemouridae										
Malenka californica	0	0	0	0	0	A	A	A	A	A
Zapada sp.	172	86	43	43	108	22	97	129	11	0
Zapada cinctipes	0	0	0	0	0	32	43	0	43	0
Zapada haysi	0	0	0	0	0	A	0	A	0	0
Other Nemouridae	0	0	0	0	0	732	1,313	2,593	1,636	75
Family Capniidae										
Capnia sp.	0	0	204	0	0	0	0	0	0	0
Other Capniidae	0	0	0	54	11	904	473	75	22	54
Family Taeniopterygidae	0	0	0	0	0	5,520	12,073	14,246	22	1,022
Family Leuctridae	0	0	0	0	0	904	1,205	785	420	269
Family Pteronarcidae										
Pteronarcys princeps	0	0	0	0	43	0	0	0	0	11
Family Perlodidae										
Megarcys signata	0	0	0	0	0	11	11	0	0	0
Other Perlodidae	11	0	0	0	22	0	0	0	0	0

Table 28.(continued)

Taxa	2 July 1975					26 September 1975				
	S-1	S-2	S-3	S-4	S-5	S-1	S-2	S-3	S-4	S-5
Family Chloroperlidae	11	86	32	527	237	161	129	226	301	570
Sweltsa coloradensis	0	A	0	0	0	0	0	0	0	0
Triznaka pintada	0	0	0	0	0	A	0	0	0	0
Family Perlidae										
Hesperoperla pacifica	11	43	32	108	65	355	452	495	301	280
Other Plecoptera	495	86	11	0	0	0	0	0	22	97
Order Trichoptera										
Family Rhyacophilidae										
Rhyacophila sp.	118	129	86	43	65	796	872	236	65	140
Family Glossosomatidae										
Agapetus sp.	11	0	11	0	0	11	0	11	0	11
Family Philopotamidae	0	0	0	0	0	108	65	280	215	0
Family Hydropsychidae										
Hydropsyche sp.	0	0	0	0	54	0	0	0	0	194
Arctopsyche sp.	0	0	0	0	11	0	0	0	32	0
Family Limnephilidae	0	0	0	0	0	11	0	0	11	43
Family Brachycentridae										
Brachycentrus sp.	0	0	32	0	0	0	0	0	0	0
Micrasema sp.	0	0	0	0	0	0	0	0	0	75
Order Hymenoptera	22	0	0	0	0	0	0	0	0	0
Suborder Chalcidoidea	0	0	0	0	0	0	0	11	0	0
Suborder Ichneumonoidea										
Family Braconidae	0	0	0	0	0	0	0	11	0	0
Order Coleoptera										
Family Elmidae	0	0	22	43	775	86	22	258	463	764
Optioservus sp.										
Family Chrysomelidae	0	0	32	0	0	0	0	0	0	0
Family Curculionidae	0	0	0	11	0	0	0	0	0	0
Order Diptera										
Family Tipulidae										
Antocha monticola	0	0	0	11	0	0	0	11	11	32
Dicranota sp.	0	0	11	0	0	11	32	22	0	43
Hexatoma sp.	0	0	0	0	0	11	0	0	0	54
Other Tipulidae	0	0	0	0	0	0	11	0	0	0
Family Tanyderidae	0	0	0	0	0	0	0	0	0	11
Family Psychodidae	0	0	0	22	11	0	0	0	194	624
Family Dixidae										
Dixa sp.	11	11	0	0	0	43	32	22	0	43
Family Simuliidae	43	54	32	0	194	22	108	97	0	280
Simulium sp.	0	0	0	0	0	0	0	0	11	0
Family Chironomidae	904	527	1,743	2,259	1,054	2,873	5,477	3,368	1,216	2,346
Family Ceratopogonidae	0	0	11	0	0	0	0	22	0	172
Family Stratiomyidae	0	0	0	0	0	0	11	0	0	0
Family Tabanidae	0	0	0	0	0	0	0	0	A	0
Family Empididae	22	11	65	75	0	43	139	377	43	22
Other Diptera	43	43	0	32	11	0	0	0	0	11

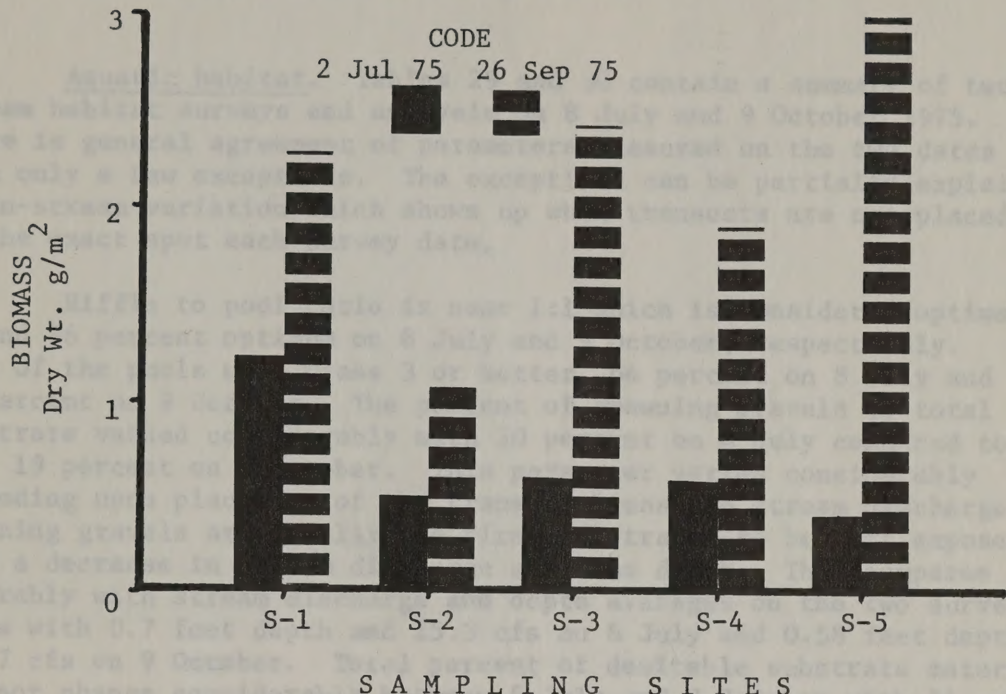


Figure 10. Comparison of macroinvertebrate standing crop (biomass) at five sites on Trout Creek on 2 July 1975 and 26 September 1975.

Stream Under Recreational Impact Analysis

Rock Creek

Plates XIII to XV show existing stream habitat plus varying conditions in Rock Creek during 1975, including spring flooding and habitat improvement efforts of BLM personnel.

Aquatic habitat. Tables 29 and 30 contain a summary of two stream habitat surveys and analysis on 8 July and 9 October 1975. There is general agreement of parameters measured on the two dates with only a few exceptions. The exceptions can be partially explained by in-stream variation which shows up when transects are not placed on the exact spot each survey date.

Riffle to pool ratio is near 1:1 which is considered optimal, 90 and 96 percent optimum on 8 July and 9 October, respectively. Most of the pools were Class 3 or better, 64 percent on 8 July and 88 percent on 9 October. The percent of spawning gravels to total substrate varied considerably with 50 percent on 8 July compared to only 19 percent on 9 October. This parameter varies considerably depending upon placement of the transect lines and stream discharge. Spawning gravels are usually the first substrates to be left exposed with a decrease in stream discharge and thus depth. This compares favorably with stream discharge and depth averages on the two survey dates with 0.7 feet depth and 15.3 cfs on 8 July and 0.58 feet depth and 7 cfs on 9 October. Total percent of desirable substrate materials did not change considerably between 8 July and 9 October with 74 and 70 percent respectively, showing desirable materials in the deeper, faster areas remained covered while the spawning beds were partially exposed during periods of low flow.

Rock Creek is largely of optimum habitat overall with 71 and 79 percent on 8 July and 9 October, respectively; but there are areas with serious habitat problems. Near the mouth where Rock Creek enters the Green River, there are numerous areas of unstable banks and habitat degradation.

Past agricultural uses of the area have resulted in the near complete removal of all native streamside vegetation except for an occasional juniper or cottonwood tree. The willows, birch, and other brush, tall weeds, and grasses are extremely sparse. The dominant vegetation is the seasonal June grass which adds almost nothing to the stability of the stream banks. With the low annual rainfall of this desert region and the poor, sandy soil, it will take a long time for the plant communities to become reestablished, if ever.

In summary, stream habitat quality is limited mainly by bank erosion and lack of deep pools with good cover.

PLATE XIII

PICTURE 1. AERIAL VIEW OF ROCK CREEK CANYON AND CONFLUENCE WITH THE GREEN RIVER ON JULY 7, 1975.

PICTURE 2. ROCK CREEK CANYON DURING RAINSHOWER ON JULY 8, 1975.

PICTURE 3. ROCK CREEK AT S-1 NEAR MOUTH SHOWING STREAM SURVEY TEAM AND RECREATIONISTS.

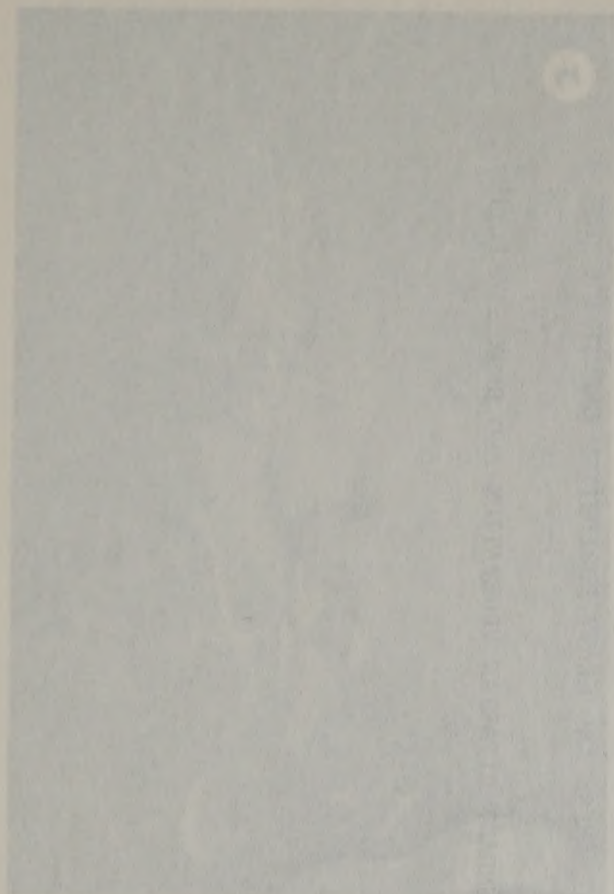
PICTURE 4. STREAM IMPROVEMENT PROJECT BY BLM PERSONNEL IN LOWER WASHED OUT REACHES OF ROCK CREEK.

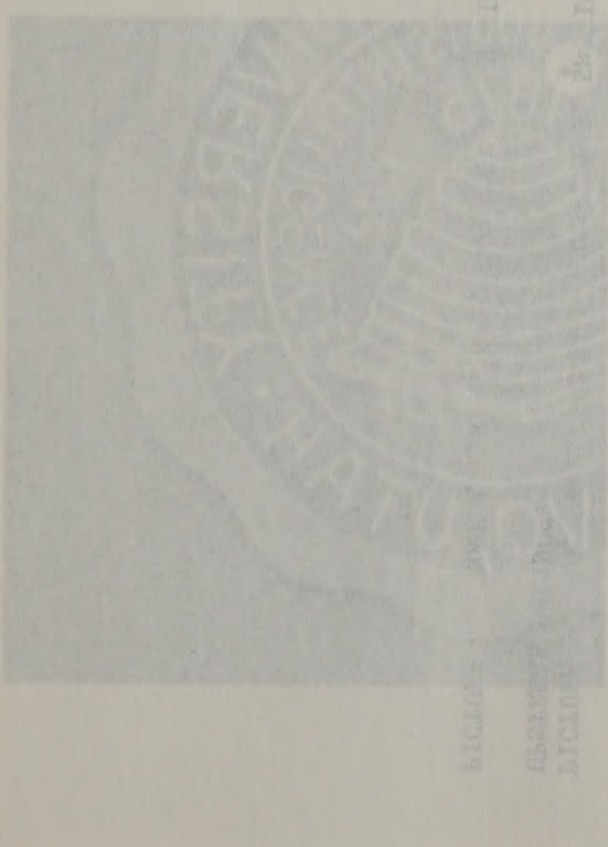

1

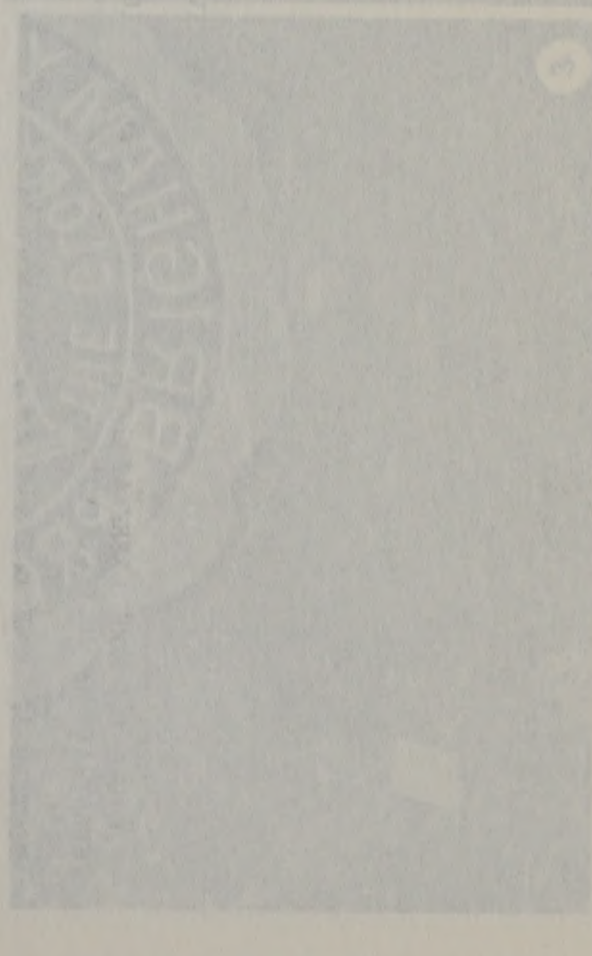

2


3


4







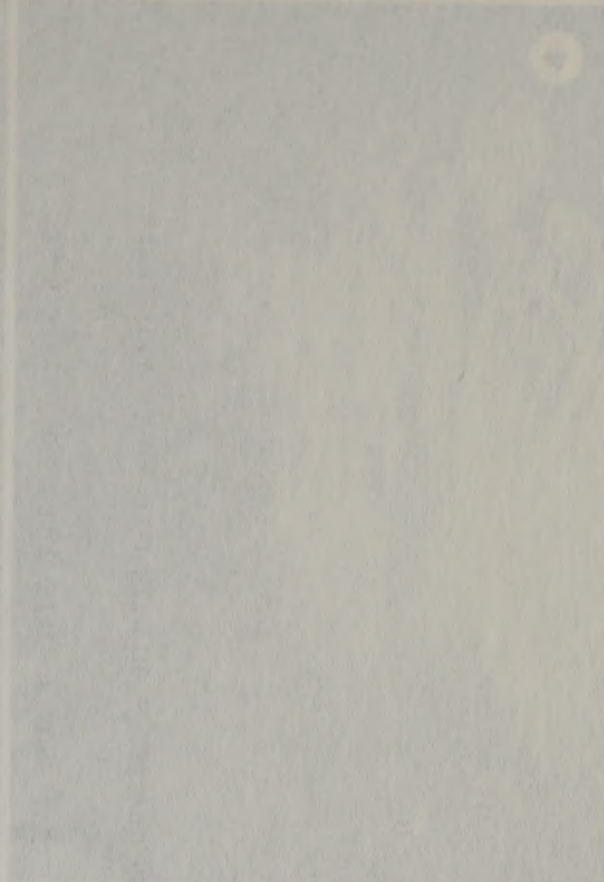


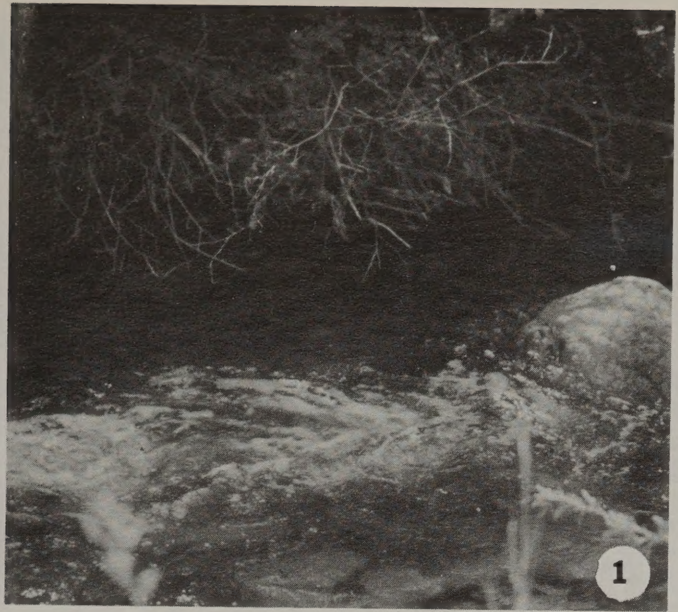
PLATE XIV

PICTURE 1. ROCK CREEK AT S-3, TRANSECT 1, SHOWING HIGH QUALITY POOL WITH GOOD COVER AND STABLE SUBSTRATE ON JULY 8, 1975.

PICTURE 2. ROCK CREEK AT S-2, TRANSECT 4, ON JULY 8, 1975, SHOWING FAIR COVER AND STABLE BANKS.

PICTURE 3. ROCK CREEK AT S-3, TRANSECT 5, SHOWING WATERCRESS AND HEAVY PERIPHYTON GROWTH DUE TO UPSTREAM SPRINGS.

PICTURE 4. ROCK CREEK AT S-3, TRANSECT 4, SHOWING ABUNDANT RIPARIAN VEGETATION AND BANK STABILITY.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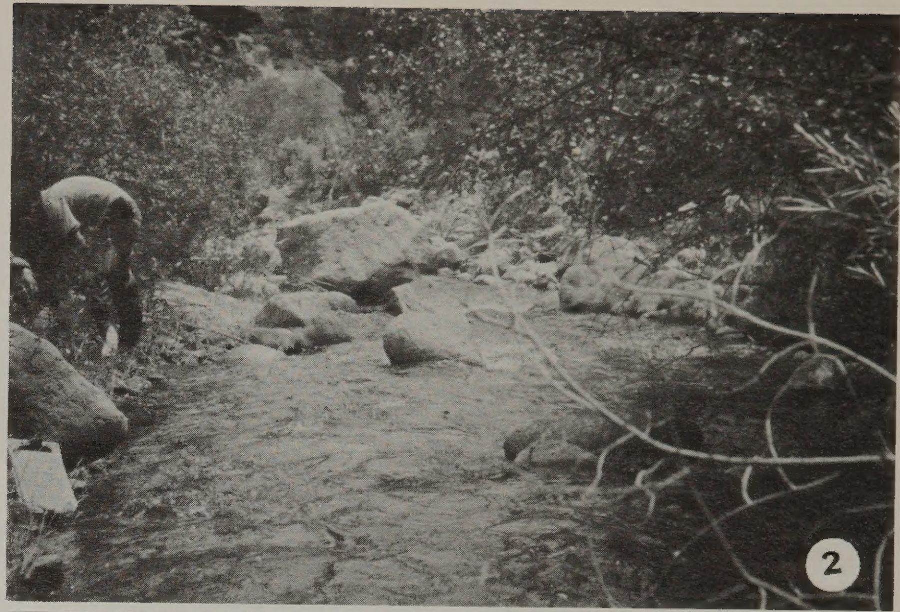
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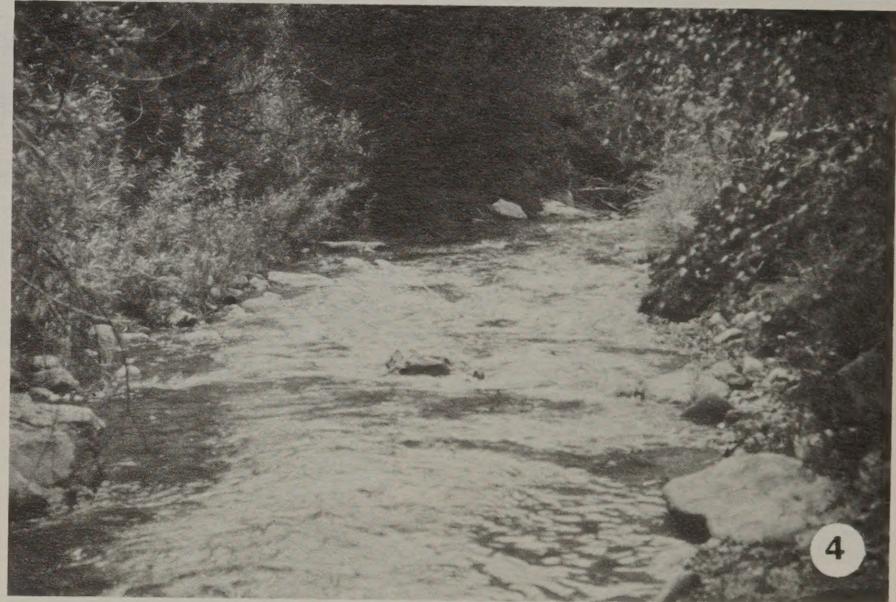
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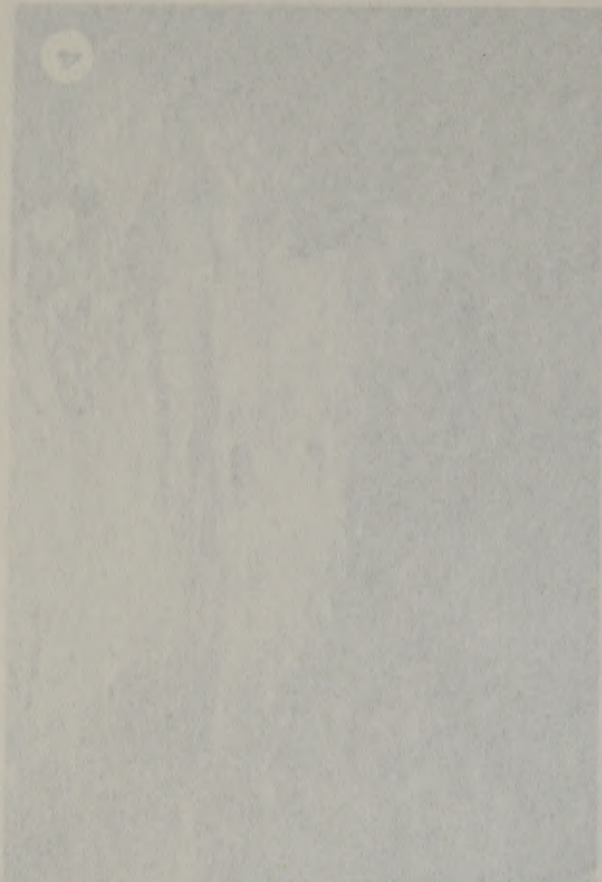
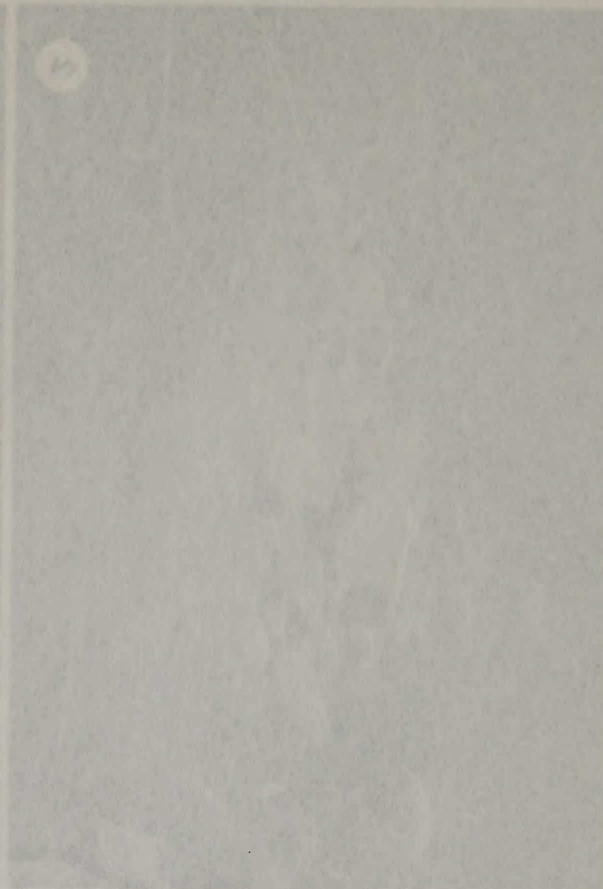
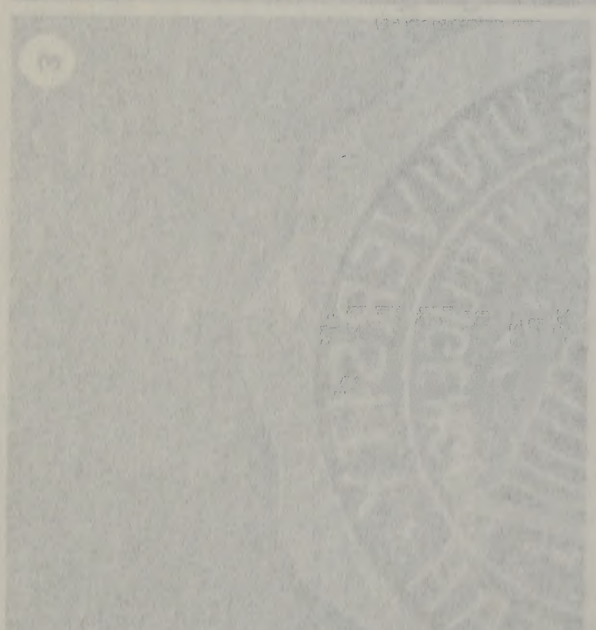
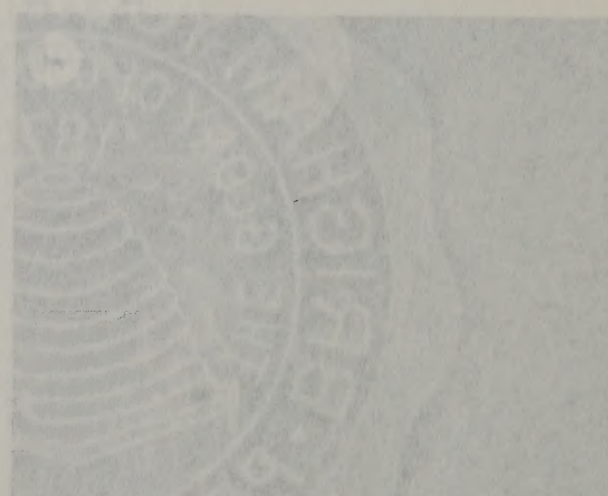








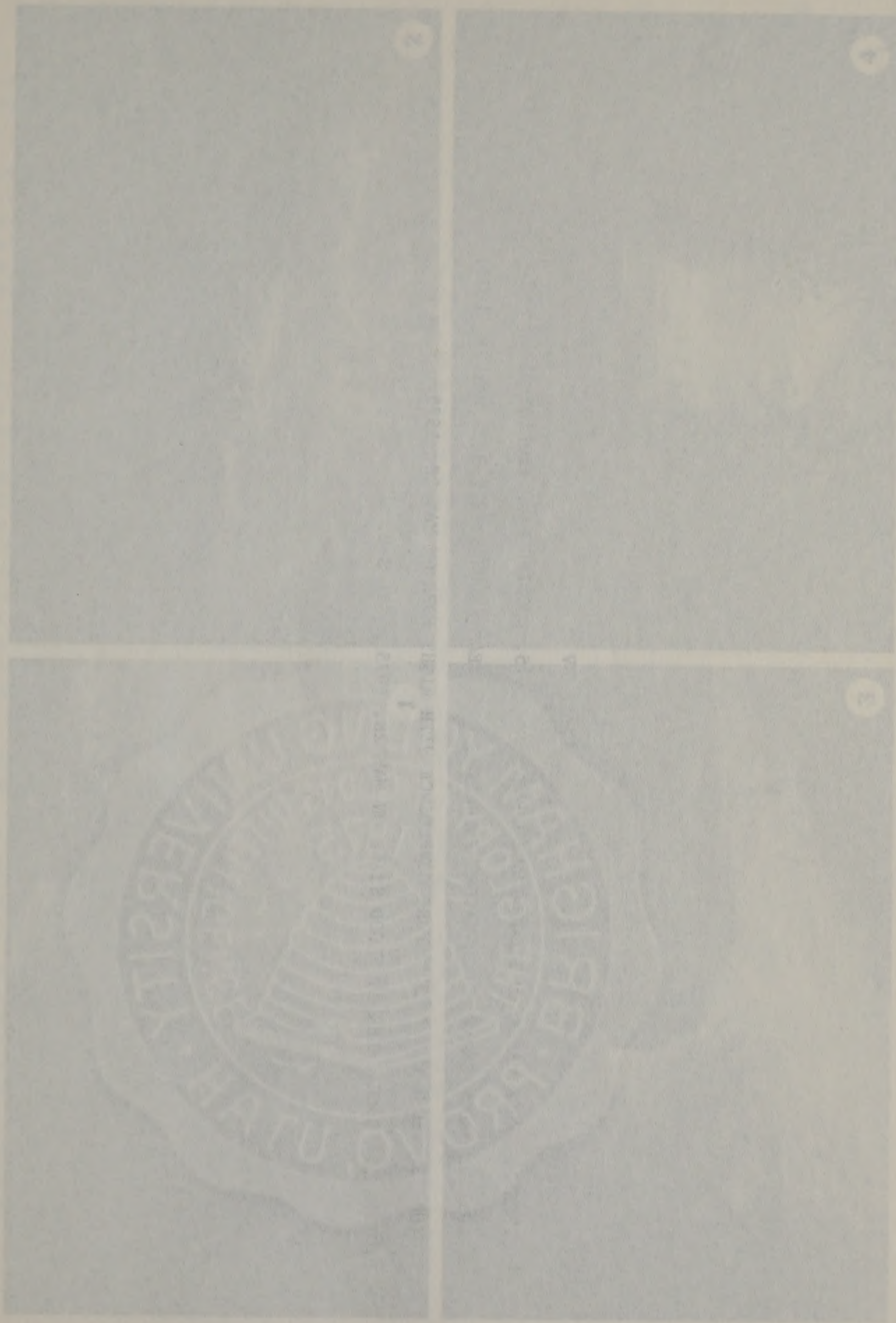


PLATE XV

PICTURE 1. ROCK CREEK IN FLOOD STAGE ON MAY 28, 1975, SHOWING BANK EROSION BELOW S-3.

PICTURE 2. ROCK CREEK FLOOD WATERS RETURNING TO STREAM BELOW SITE S-3 ON MAY 28, 1975.

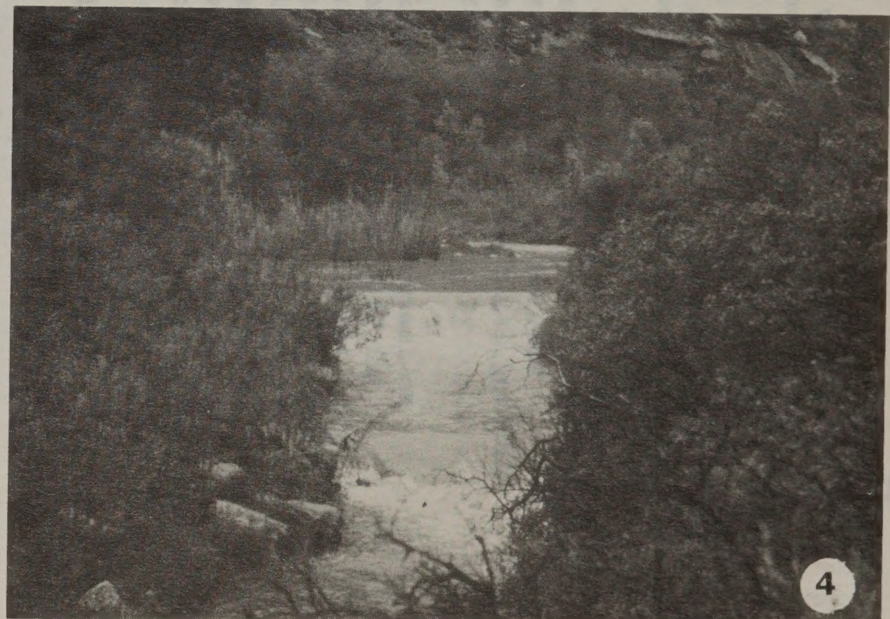
PICTURE 3. ROCK CREEK LEFT FORK CONFLUENCE WITH RIGHT FORK ON MAY 28, 1975.

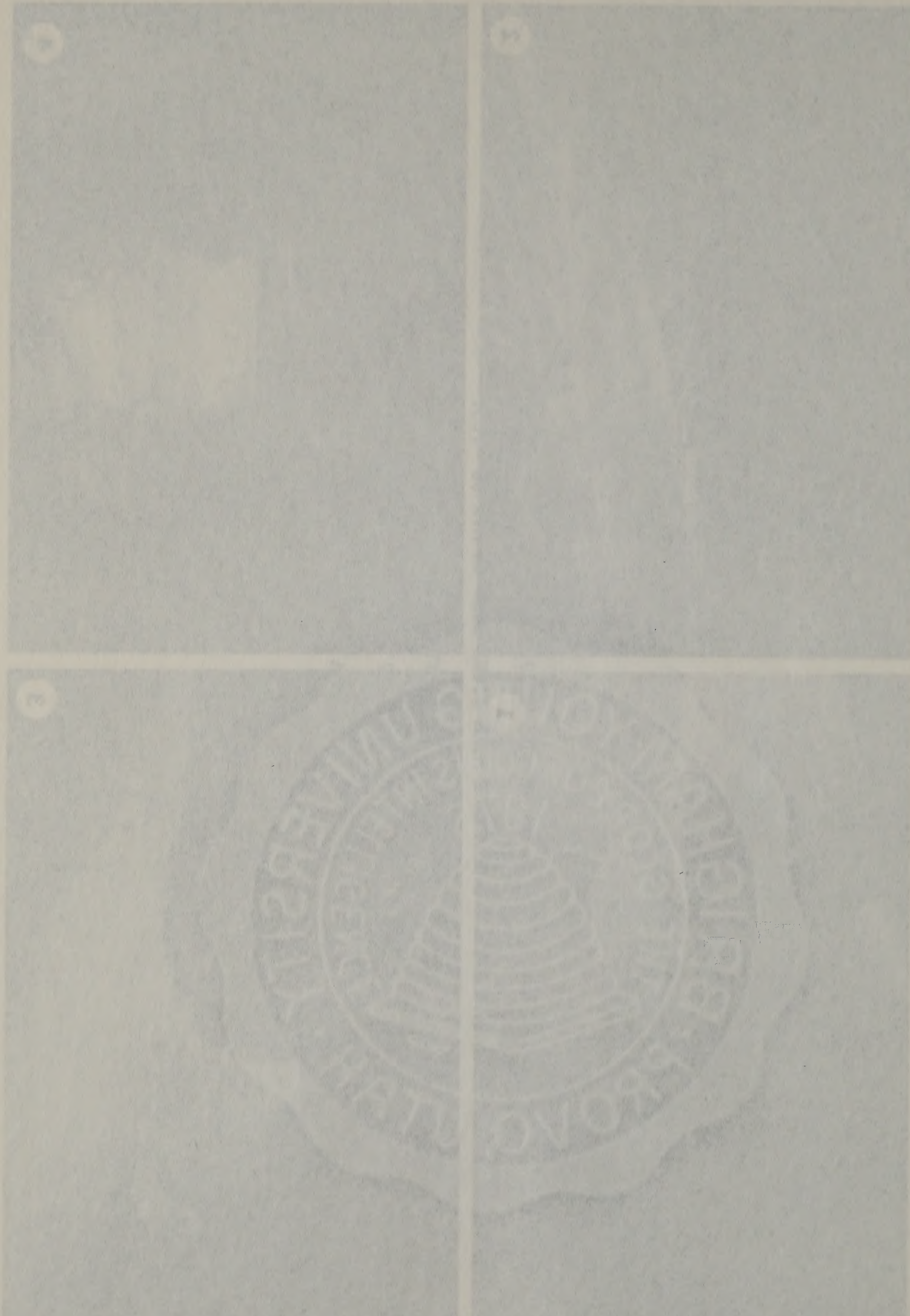
PICTURE 4. ROCK CREEK AT FLOOD STAGE ON MAY 28, 1975 ABOVE S-2.


1


2


3


4



Water quality. According to the water quality analyses presented in Table 31, Rock Creek is a moderately hard water, bicarbonate buffered, cold water stream.

Along the perennial stream reach in the Rock Creek drainage from the forks 2 miles upstream dense growths of deciduous trees and shrubs occur with resultant heavy winter leaf packs on the ground. These leaves decompose during the winter and the nitrates and phosphates produced are leached into the stream during runoff. This explains the higher nitrate nitrogen levels in May as compared to October (Table 31). It appears that the main limiting factor to algal growths is the near absence of available phosphorus.

Bacterial samples from Rock Creek on 8 July 1975 reveal an erratic distribution of total coliform and fecal streptococci in the stream course (Table 31). Apparently there were some point sources of bacteria with 2,100/100 ml total coliform from S-2 compared to 410 and 700 from S-1 and S-3, respectively. Fecal coliform followed a more expected distribution with 7/100 ml at S-1 and 40/100 ml at S-2 and S-3. Bacterial samples have to be kept in cold storage for two to three days before they can be processed, thus the reliability of these sample data is low. It appears evident, though, that Rock Creek generally has bacteria levels well within the Utah Class CC standards of a monthly mean not to exceed 5,000/100 ml of total coliforms. Levels do indicate that care should be taken when using the waters for drinking purposes. There evidently are upstream natural sources of bacteria, either from wildlife or domestic animals.

Overall water quality is excellent for maintaining a coldwater fisheries. Nutrient levels are probably the main water quality limiting factor.

Macroinvertebrate communities. The macroinvertebrates reflect the instability in Rock Creek better than the physical-chemical surveys.

Table 35 represents the statistical analysis of reliability of benthic sampling in Rock Creek. This analysis was run for one station only as the same methods were used at all sites. With a coefficient of variation of only 20.9 on 9 July and 23.5 on 8 October 1975, the data is reliable with only a small variance. This means the estimate of the population mean is close to the real mean and the invertebrates are only moderately clustered in their distribution.

The two diversity indices, $\bar{d}$ (Shannon and Weaver, 1963) and H (Wilhm, 1968) are both dominance diversity indices based upon the information theory which, in summary is: if total numbers of organisms are evenly distributed over several species, the information

gained by studying additional specimens is greatest because the chance of one specimen being different from the preceding one is greatest; and conversely, when the number of organisms is dominated by one or two species, the information gained by studying additional specimens is least because the chance of one specimen being different from the preceding one is least.

A $\bar{d}$ or H value below 2.0 is poor compared to an optimal cold-water trout stream; but values from 1.0 to 2.0 are not uncommon in desert streams, especially those subject to periodic extremes in flow from storm runoff highs to winter and drought lows. Rock Creek shows evidence of periodic high flows with accompanying scouring and bank erosion.

The macroinvertebrate community at S-1 had lower dominance by any one order than S-2 or S-3 on both collection dates (Table 36). This is significant in assessing environmental quality for the three stations. Numbers of organisms per meter square at S-1 were consistently lower than at S-2 or S-3 but $\bar{d}$ and H were higher (Table 36). This indicates that S-1 is subjected to stresses which are largely non-selective for any certain species, but rather, affect nearly all species. Physical stress from fluctuating flows, bank erosion, scouring, and siltation fall under that category.

The macroinvertebrate community at S-1 owes its diversity and relative abundance mainly to a constant replenishing of organisms drifting downstream from upstream communities in the more stable habitat areas. The three most dominant forms (chironomid midges, simuliid blackflies, and baetid mayflies) (Table 37) are all active drifters and are often the first to repopulate an area following an environmental perturbation.

Another indicator of biotic condition is the available biomass (standing crop) of macroinvertebrates. Figure 11 illustrates the standing crop at the three stations on Rock Creek on 9 July and 8 October 1975. It is obvious that there is a general degradation in available energy for the fisheries of Rock Creek proceeding downstream from the forks. The stream reach from S-2 upstream acts as the "bread basket" for the lower stream areas by producing high numbers and biomass which recharges the lower sections through downstream drift. Springs above S-3 produce dense growths of water-cress and attached algal mats which are largely responsible for the high numbers and biomass of the invertebrate communities in this area.

In May, 1975 flows in Rock Creek were near flood stage. This resulted in bank cave-ins along several sections of the stream and a generalized scouring of substrates. Water velocities and depths prevented any sampling but the low $\bar{d}$ and H values (Table 36) on 9 July 1975 indicate the damage was severe and recovery was slow. The low $\bar{d}$ and H values were in direct response to the strong dominance by dipterans (chironomid midges and simuliid blackflies) as shown in

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Table 37. By 8 October 1975, $\bar{d}$ and H were significantly higher at S-2 and S-3, but about the same at S-1. Baetid mayflies increased in dominance at all stations (Tables 36 and 37).

Table 37 gives the distribution and relative abundance of taxa collected at Rock Creek during 1975. There are several taxa which are indicative only of good clean cold-water stream systems. Of these, the most significant are the stoneflies *Claassenia sabulosa*, *Hesperoperla pacifica*, *Isoperla ebria*, Capniidae, and *Zapada* sp. Also, the mayflies *Cinygmula* sp. and *Ephemerella doddsi* are limited quite narrowly in their environmental tolerances.

Of the caddisflies, *Arctopsyche* spp. are relatively intolerant to environmental stresses. The other taxa range from moderately intolerant to extremely tolerant to environmental stresses.

This biotic system is highly resilient and can survive considerable environmental stress, but several species are not so resilient and could be lost. The diversity of organisms guarantees a continuation of the systems, but if a preservation of species diversity is the goal, then strict habitat management should be the approach.

Management alternatives. Rock Creek is the prime source of potable water for recreationalists floating down the Green River. It is obvious that the use of the Green River will not diminish; thus, the use of Rock Creek will not diminish.

The impacts on Rock Creek in the past have come mainly from: (1) agricultural use--grazing and cultivation of crops; (2) erosion of watershed and stream banks following summer storms and winter snow melt; (3) bacterial contamination from domestic animals, wildlife, and human wastes; and (4) pollutants such as soap, toothpaste, food wastes from washing dishes, and detergent from washing clothes and dishes. Crop cultivation has ceased along with most domestic animal grazing, although there are occasional cattle seen in the valley. This discussion is going to deal primarily with recreational use management alternatives.

Some management alternatives for Rock Creek are:

1. Do not allow camping, cooking, washing, fishing, or defecation anywhere in a zone enclosing Rock Creek. Maintain Rock Creek as solely a potable water source.

2. Do not allow overnight camping at Rock Creek but allow day camps for sight-seeing, hiking, fishing, and limited sanitary duties. Defecation would have to be limited to certain zones with strict enforcement of methods such as depth of hole, handling of paper, etc. Washing of persons, clothes, and dishes would have to be strictly controlled.

3. A zone of Rock Creek, perhaps the lower 300 feet, could be considered a sink for all recreational impacts and all human activities limited to this section in an effort to contain use in a small section while preserving the larger section upstream. Chemical pit toilets could be installed along with permanent fire pits. This certainly would not add to the "wild river" image, but it might help contain impact to a smaller area while preserving the wild habitat in surrounding areas. This would be a trade-off type of management.

The management choices for Rock Creek do not realistically include elimination of all impacts from recreational use; but rather, are choices as to what level the impacts should be allowed to go. If Green River use keeps increasing, one alternative would be to establish a ranger station at Rock Creek during the peak use periods.

Lower Rock Creek, at present, is of low biological quality and should come under habitat improvement and/or recreational use development, including at least sanitary refuse facilities. The authors of this report recommend allowing use of Rock Creek with permanent facilities provided. Regulations concerning use would have to be clearly defined and presented to all users. Regular inspection of the area, including a ranger residing at Rock Creek during peak-use periods would be desirable. This should allow maximum use of the resource with controlled impact. Regular water chemistry, macroinvertebrate community characteristics, and bacterial determinations should be made.

Table 29. Stream habitat survey summary and analysis for Rock Creek on 8 July 1975.

1. State, County Utah, Carbon	2. District Moab	3. Resource Area--P.U. Price River-- Range Creek
4. Drainage Green River	5. Stream Unit Rock Creek	6. Location T. 15S R. 17E Sect. 5
7. Investigators Winget and Reichert		8. Date 8 July 1975

General Data	
9. Total length of stream (mi.)	≈5
10. Total length of stream surveyed (mi.)	
a. BLM	4
b. Public	--
c. Private	--
11. Total No. sample stations:	
a. BLM	3
b. Public	--
c. Private	--
12. Total of all stream width measurements (ft.)	159
13. Total channel width (ft.)	271
14. Total width--all pools (ft.)	72
15. Total width of all pools classed 1, 2, and 3 (ft.)	51
16. Total footage of desirable bottom materials (ft.)	117
17. Total spawning gravels (ft.)	80
18. Sum of cover ratings	63
19. Sum of stability ratings	59
20. Elevation: (MSL)	
a. Lowest	4,455
b. Highest	4,780
21. Multiple use zones	Recreation Water Remote
22. Number of camera points	
23. Total cost	
a. Planning	
b. Salaries	
c. Equipment	
d. Analysis of data	
24. Cost per station	

Priority A Limiting Factors	
25. Percent of total stream width in pools	45%
26. Pool-riffle ratio, % optimum	90
27. Pool quality, % optimum	64
28. Percent of stream bottom with desirable materials	74
29. Percent spawning gravels	50
30. Bank cover, % optimum	66
31. Bank stability, % optimum	61
32. Percent of habitat optimum	71

Priority B Limiting Factors	
33. Average depth of stream (ft.)	0.7
34. Average width of stream (ft.)	13
35. Average width of channel (ft.)	23
36. Percent of bottom with clinging vegetation (ft.)	5%
37. Percent of bottom with rooted vegetation (ft.)	5%
38. Percent stream shade	47
39. Average stream gradient (%)	3
40. Average stream velocity (f/s)	1.41
41. Stream discharge (cfs)	15.3
42. Average water temperature: (°F or °C)	14° C
43. Average Air Temperature (°F or °C)	22° C
44. Turbidity description (clear)	0 JTU
45. Access (mi.):	
a. Remote (Boat, river)	
b. Low standard trails	4
c. Improved trails	
d. Low standard roads	
e. Improved roads	
46. Water quality analysis:	
a. Hach kit (pH, Tur., CO_2, DO)	
b. Chemical (BYU)	
c. Coli (BYU)	

Table 30. Stream habitat survey summary and analysis for Rock Creek for 9 October 1975.

1. State, County Utah, Carbon	2. District Moab	3. Resource Area--P.U. Range Creek
4. Drainage Green River	5. Stream Unit Rock Creek	6. Location T. 15S R. 17E Sect. 5
7. Investigators Winget, Duff, and Reichert		8. Date 9 October 1975

General Data

9. Total length of stream (mi.)	≈5
10. Total length of stream surveyed (mi.)	
a. BLM	4
b. Public	--
c. Private	--
11. Total No. sample stations:	
a. BLM	3
b. Public	--
c. Private	--
12. Total of all stream width measurements (ft.)	196
13. Total channel width (ft.)	325
14. Total width--all pools (ft.)	101
15. Total width of all pools classed 1, 2, and 3 (ft.)	93
16. Total footage of desirable bottom materials (ft.)	137
17. Total spawning gravels (ft.)	37.5
18. Sum of cover ratings	83
19. Sum of stability ratings	84
20. Elevation: (MSL)	
a. Lowest	4,455
b. Highest	4,780
21. Multiple use zones	recreation water remote
22. Number of camera points	≈9
23. Total cost	
a. Planning	
b. Salaries	
c. Equipment	
d. Analysis of data	
24. Cost per station	

Priority A Limiting Factors

25. Percent of total stream width in pools	52%
26. Pool-riffle ratio, % optimum	96
27. Pool quality, % optimum	88
28. Percent of stream bottom with desirable materials	70
29. Percent spawning gravels	19
30. Bank cover, % optimum	69
31. Bank stability, % optimum	70
32. Percent of habitat optimum	79

Priority B Limiting Factors

33. Average depth of stream (ft.)	0.58
34. Average width of stream (ft.)	13.1
35. Average width of channel (ft.)	21.7
36. Percent of bottom with clinging vegetation (ft.)	5%
37. Percent of bottom with rooted vegetation (ft.)	<1
38. Percent stream shade	40
39. Average stream gradient (%)	4.8
40. Average stream velocity (f/s)	1.5
41. Stream discharge (cfs)	7
42. Average water temperature: (°F or °C)	10.2° C
43. Average Air Temperature (°F or °C)	8.7° C
44. Turbidity description (clear)	0 JTU
45. Access (mi.):	
a. Remote (boat, river)	
b. Low standard trails	4
c. Improved trails	
d. Low standard roads	
e. Improved roads	
46. Water quality analysis:	
a. Hach kit	
b. Chemical (BYU)	
c. Coli (BYU)	

Table 31. Water quality analysis of Rock Creek.

Analysis* by	Test	29 May 1975 S-3	8 July 1975 S-1	8 July 1975 S-3**	9 October 1975 S-1	9 October 1975 S-3
	Time		1415	1000	0900	1600
1, 2	Alkalinity, total as $CaCO_3$, mg/l	208	--	221	248	249
1, 2	Bicarbonate as HCO_3^-, mg/l	225	--	269	289	299
1, 2	Boron as B, mg/l	--	--	50	--	--
1, 2	Calcium as Ca, mg/l	49	--	42	50	52
1, 2	Carbonate as CO_3, mg/l	14	--	0	7	2
1, 2	Chloride as Cl, mg/l	2.15	--	2.8	4	3
3, 2	Conductivity, µmhos/cm (25° C)	--	--	500	581	572
1, 2	Hardness as $CaCO_3$, mg/l	218	--	220	258	269
1	Hydroxide as OH, mg/l	0.04	--	--	<0.1	<0.1
1, 2	Magnesium as Mg, mg/l	23	--	28	32	34
3, 1	pH	8.36	8.0	7.8	8.5	8.4
1, 2	Potassium as K, mg/l	0.9	--	0.9	0.9	1.0
1, 2	Sodium as Na, mg/l	11.8	--	23	42	37
1, 2	Sulfate as SO_4, mg/l	23	--	50	78	74
1	Total Dissolved Solids	267	--	--	352	351
3	Turbidity, JTU's	--	0	0	0	2
3	Dissolved Oxygen as O_2, mg/l	--	9	8	--	--
1, 2	Nitrate as N, mg/l	0.33	--	0.03	<0.05	<0.05
1, 2	Phosphate (Total) as P, mg/l	<0.001	--	--	--	--
1, 2	Phosphate (Ortho) as P, mg/l	<0.001	--	0.04	0.002	0.003
3	Air Temperature, °C	--	32	--	3	13
3	Water Temperature, °C	--	19	14	8	10.5
4	Total Coliform, MPN/100 ml	--	410	700	--	--
4	Fecal Coliform, MPN/100 ml	--	7	40	--	--

*1. BYU Environmental Analysis Laboratories
2. USGS
3. Field determinations
4. Bionics
5. Utah Department of Health and Welfare

**All in this column were by USGS

Table 32. Rock Creek water temperature data--daily minimum and maximum (°C) for 8 July through 21 August 1975.

Date	Min	Max	Date	Min	Max	Date	Min	Max
July 8	13.5	15.0	July 23	11.5	16.5	Aug. 7	11.5	16.0
9	13.0	15.5	24	11.5	16.0	8	10.5	15.5
10	13.0	16.5	25	11.5	15.5	9	10.5	15.5
11	12.0	14.0	26	12.0	16.0	10	10.5	15.0
12	12.0	15.5	27	11.5	16.0	11	11.5	14.0
13	12.0	15.5	28	11.5	15.5	12	11.0	13.5
14	12.0	17.5	29	12.5	14.5	13	11.0	12.0
15	12.5	16.0	30	12.0	15.5	14	11.0	13.5
16	12.5	14.5	31	11.5	14.0	15	10.5	14.0
17	11.5	15.5	Aug. 1	11.0	15.5	16	10.5	13.5
18	12.0	16.5	2	11.0	15.0	17	10.0	15.0
19	12.0	17.0	3	10.5	15.0	18	10.0	14.0
20	12.5	15.5	4	10.5	15.5	19	10.0	12.0
21	12.0	16.0	5	10.5	15.0	20	10.0	11.5
22	11.5	16.0	6	11.0	15.0	21	10.0	14.0
15-day mean	14.0		15-day mean	13.4		15-day mean	12.3	

Table 33. Rock Creek water temperature data--daily minimum and maximum (°C) for May 30 through July 2, 1975.

Date	Min	Max	Date	Min	Max
May 30	4.0	10.5	June 16	5.5	6.0
31	6.0	9.0	17	5.0	6.0
June 1	6.5	13.0	18	5.5	7.0
2	6.5	12.0	19	5.5	7.0
3	6.5	10.0	20	5.0	7.0
4	4.5	11.0	21	5.5	8.5
5	5.0	11.0	22	6.0	12.0
6	6.0	10.5	23	7.0	12.5
7	6.0	9.0	24	7.0	12.5
8	6.0	9.0	25	7.0	10.0
9	4.0	7.0	26	5.0	11.0
10	4.0	6.0	27	6.0	11.5
11	4.0	10.0	28	7.0	13.0
12	4.5	10.5	29	8.0	13.0
13	6.5	12.5	30	8.0	13.5
14	7.5	8.5	July 1	8.5	14.0
15	5.5	7.0	2	9.0	15.0
15-day mean	7.6		15-day mean	8.5	

Table 34. Rock Creek water temperature data--daily minimum and maximum (°C) for September 20 to October 5, 1975.

Date	Min	Max
Sep. 20	7.0	9.0
21	7.0	9.0
22	7.0	9.5
23	7.5	9.5
24	7.5	10.0
25	8.0	9.5
26	7.5	9.5
27	7.5	9.5
28	7.5	9.5
29	7.5	9.5
30	7.5	8.5
Oct. 1	7.5	9.0
2	7.5	9.0
3	7.5	9.0
4	7.5	9.0
5	8.0	9.0
15-day mean	8.4	

Table 35. Statistics for stepwise pooled samples for Rock Creek Site S-3 on 9 July 1975 and 8 October 1975.

Step*	Total No. of Taxa	Mean No/ft^2	80% Confidence Limits LL	80% Confidence Limits UL	Standard Deviation	Percent SE of Mean	Coefficient of Variation	$\bar{d}$	H
9 July 1975									
1	18	undefined	undefined	undefined	undefined	undefined	undefined	1.50	1.47
2	19	1,463.5	603.2	2,323.8	395.3	19.1	27.0	1.42	1.40
3	21	1,410.3	1,089.9	1,730.8	294.3	12.0	20.9	1.46	1.44
8 October 1975									
1	13	undefined	undefined	undefined	undefined	undefined	undefined	2.05	2.04
2	21	7,240.5	3,092.9	11,388.1	1,905.6	18.6	26.3	2.16	2.13
3	23	6,756.0	5,027.5	8,484.5	1,587.4	13.6	23.5	2.20	2.18

*Step 1 consists of only one sample; Step 2 is the results from 2 pooled samples; Step 3 is the results from 3 pooled samples, etc.

Table 36. Summary of macroinvertebrate community analysis for Rock Creek on 9 July 1975 and 8 October 1975.

Sampling Site	Number of Taxa	Total $\bar{X}$ Number/m^2	% Ephemeroptera	% Plecoptera	% Trichoptera	% Coleoptera	% Diptera	% Other Invertebrates	$\bar{d}$	H
S-1										
9 July 1975	14	2,928	20	2	4	1	64	9	2.42	2.31
8 October 1975	21	30,450	42	1	23	1	28	4	2.33	2.31
S-2										
9 July 1975	19	50,195	1	0.4	0.5	0.3	91	7	1.55	1.54
8 October 1975	19	44,224	34	2	28	0.2	32	4	2.24	2.23
S-3										
9 July 1975	21	15,182	2	0.4	2	0.5	91	4	1.46	1.44
8 October 1975	23	72,705	31	2	32	0.4	33	2	2.20	2.18

Table 37. Number per meter square of macroinvertebrate taxa collected from Rock Creek.

Taxa	9 July 1975 S-1	9 July 1975 S-2	9 July 1975 S-3	8 October 1975 S-1	8 October 1975 S-2	8 October 1975 S-3
Phylum Platyhelminthes						
Class Turbellaria						
Order Tricladia (Planaria)	0	0	11	0	0	0
Phylum Aschelminthes						
Class Nematoda	0	86	0	0	0	43
Phylum Mollusca						
Class Gastropoda	0	0	0	377	0	0
Phylum Annelida						
Class Oligochaeta	151	2,475	312	387	829	463
Phylum Arthropoda						
Class Arachnida						
Order Acarina						
Suborder Hydracarina	108	925	301	904	764	1,130
Class Crustacea						
Order Ostracoda	11	484	204	97	742	1,248
Order Copepoda	0	0	0	0	0	11
Class Insecta						
Order Collembola						
Family Poduridae						
<u>Podura aquatica</u>	11	0	0	0	0	0
Order Ephemeroptera						
Family Baetidae						
<u>Baetis</u> spp.	592	656	194	12,622	15,107	22,026
Family Heptageniidae						
<u>Cinygmula</u> sp.	0	0	0	0	11	32
<u>Epeorus</u> sp.	0	0	0	0	11	161
<u>Epeorus longimanus</u>	0	32	75	0	0	0
Other Heptageniidae	0	0	32	0	0	0
Family Leptophlebiidae						
<u>Paraleptophlebia</u> sp.	0	0	0	11	0	11
Family Ephemerellidae						
<u>Ephemerella doddsi</u>	0	0	0	0	0	32
Other Ephemeroptera	0	0	0	11	0	0
Order Odonata						
Suborder Zygoptera	0	0	0	11	0	0
Order Plecoptera						
Family Nemouridae						
<u>Malenka</u> sp.	11	0	0	0	0	0
<u>Zapada</u> sp.	0	0	0	0	0	32
Family Capniidae	0	0	0	32	54	32
Family Taeniopterygidae	0	0	0	54	32	43
Family Leuctridae	0	0	0	11	11	129
Family Perlodidae						
<u>Isoperla</u> spp.	11	43	32	161	463	1,334
<u>Isoperla ebria</u>	0	0	A	0	0	A
Family Perlidae						
<u>Hesperoperla pacifica</u>	0	11	22	22	129	118
<u>Claassenia sabulosa</u>	32	11	0	0	0	0
Other Plecoptera	11	129	11	0	0	0

Table 37. (continued).

Taxa	9 July 1975 S-1	S-2	S-3	8 October 1975 S-1	S-2	S-3
Order Trichoptera						
Family Rhyacophilidae						
Rhyacophila sp.	0	0	32	11	0	0
Family Psychomyiidae						
Tinoides sp.	22	0	0	0	0	0
Other Psychomyiidae	0	0	0	172	0	0
Family Hydropsychidae						
Hydropsyche spp.	65	215	129	6,854	12,471	22,865
Arctopsyche sp.	22	0	0	0	0	0
Family Hydroptilidae						
Hydroptila sp.	0	43	0	0	0	0
Other Hydroptilidae	0	0	54	75	97	32
Family Lepidostomatidae						
Lepidostoma sp.	0	0	32	0	0	0
Family Brachycentridae						
Micrasema sp.	0	0	0	0	0	54
Other Trichoptera	0	11	22	0	0	0
Order Lepidoptera	0	11	0	0	0	0
Order Hymenoptera						
Family Ichneumonidae	0	0	0	0	0	11
Order Coleoptera						
Family Elmidae	22	151	65	420	86	291
Family Dytiscidae	0	0	11	0	0	0
Order Diptera						
Family Tipulidae						
Antocha monticola	0	0	0	11	0	11
Hexatoma spp.	0	54	86	54	355	215
Holorusia grandis	0	0	11	0	0	32
Family Simuliidae						
Simulium spp.	742	16,409	2,744	3,992	2,981	3,949
Family Chironomidae	1,098	28,805	10,921	4,508	10,749	19,594
Family Ceratopogonidae *Palpomyia* or *Bezzia*	43	151	86	43	32	0
Family Stratiomyidae						
Euparyphus sp.	0	11	0	0	11	0
Family Empididae	0	54	11	97	0	118
Family Muscidae						
Limnophora sp.	0	11	0	0	32	0

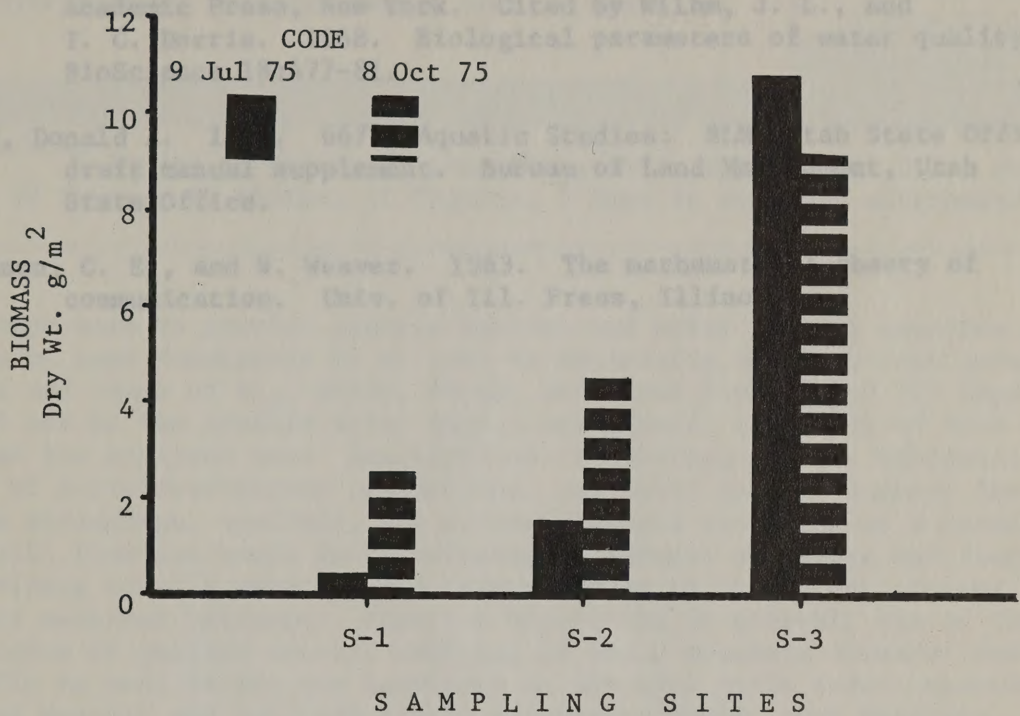

Figure 11. Comparison of macroinvertebrate standing crop (biomass) at three sites on Rock Creek on 9 July 1975 and 8 October 1975.

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16. Abstract

These surveys were to provide aquatic habitat and water quality baseline date to the U. S. Bureau of Land Management to be used in evaluating (1) livestock grazing impacts on the flora and fauna of Big, Birch, Thoms, and Trout Creeks; and (2) impacts from recreational use on the potable water supply and aquatic ecosystem of Rock Creek.

Included in the analyses are: descriptions of existing aquatic habitats; characterizations of macroinvertebrate communities; and water quality summary for each stream. The assemblage, analysis, and recommendations presented as a result of this study will form the basis for land/water management decisions and future studies involving aquatic habitats and related fauna in these Utah streams.

Preliminary analyses indicate: riparian vegetation is probably one of the most critical factors of quality aquatic habitats in small mountain streams; and near optimum riffle to pool ratios are important as too many pools reduce macroinvertebrate diversity and density and too much riffle eliminates needed fish habitats.

17a. Descriptors
*Watershed management, *Macrobenthos, *Stream improvement, *Water quality, *Coliforms, Bank stability, Land management, Grazing, Cutthroat trout.

17b. Identifiers
Environmental Impact Evaluation, National Resource Lands, Critical Aquatic Habitat, Pure Strain Cutthroat Trout, Grazing Impacts, Recreational Impacts, BLM administered streams

17c. COWRR Field & Group 06G, 05C

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